Wl. H. B. Fletcher. M.A.

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ARITHMETICK:

BEING

A plain and familiar Method, ſuitable to the meaneſt Capacity for the full underſtanding of that Incomparable Art, as it is now taught by the ableſt School-Maſters in City and Countrey.

COMPOSED

By *Edward Cocker*, late Practitioner in the Arts of Writing, Arithmetick, and Engraving. Being that ſo long ſince promiſed to the World.

PERUSED and PUBLISHED

By *John Hawkins* Writing-Maſter near St. *Georges* Church in *Southwark*, by the Authors correct Copy, and commended to the World by many eminent Mathematicians and Writing-Maſters in and near *London*.

This Impreſſion is corrected and amended, with many Additions throughout the whole.

Licenſed *Sept.* 3. 1677. *Roger L'Eſtrange.*

LONDON,

Printed by *J. R.* for *Eben Tracey*, at the *Three Bibles* on *London-Bridge*. 1696.

Ingenious COCKER! (Now to Rest thou'rt Gon
Noe Art can Show thee fully but thine own
Thy rare Arithmetick alone can Show
Th'vast Sums of Thanks wee for thy Labour owe

by John Hawkins, Writing Master

TO his much Honoured Friends, *Manwaring Davies* of the *Inner Temple*, Esquire; and Mr. *Humphry Davies* of St. *Mary Newington-Buts*, in the County of *Surrey*.

John Hawkins, As an Acknowledgment of unmerited Favours, humbly Dedicateth this *Manual of Arithmetick*.

To the READER.

Courteous Reader,

I Having the Happineſs of an Intimate Acquaintance with Mr. *Cocker* in his Lifetime often ſollicited him to remember his Promiſe to the VVorld, of Publiſhing his Arithmetick, but (for Reaſons beſt known to himſelf) he refuſed it; and (after his Death) the Copy falling accidentally into my hands, I thought it not convenient to ſmother a work of ſo conſiderable a moment, not queſtioning but it might be as kindly accepted, as if it had been preſented by his own hand. The Method is familiar and eaſie, diſcovering as well the Theorick as the Practick of that Neceſſary Art of Vulgar *Arithmetick*: And in this new Edition there are many remarkable Alterations for the benefit of the Teacher or Learner, which I hope will be very acceptable to the VVorld: I have alſo performed my promiſe in Publiſhing the *Decimal Arithmetick*, which finds encouragement to my Expectation, and the Bookſellers too, I am

Thine to ſerve thee,

John Hawkins.

Mr.

Mr. *Edward Cocker's*

PROEME or PREFACE.

BY the ſacred Influence of Divine Providence, I have been Inſtrumental to the benefit of many; by vertue of thoſe uſeful Arts, Writing *and* Engraving: *And do now with the ſame wonted alacrity caſt this my Arithmetical Mite into the Publick Treaſury, beſeeching the Almighty to grant the like bleſſing to theſe as to my former Labours.*

Seven Sciences ſupremely excellent,
Are the chief Stars in Wiſdoms Firmament:
Whereof Arithmetick is one, whoſe worth
The Beams of Profit and Delight ſhines forth;
This crowns the reſt; this makes man's mind complete;
This treats of Numbers, and of this we treat.

I have been often deſired by my intimate Friends to publiſh ſomething on this ſubject; who in a pleaſing Freedom have ſignified to me that they expected it would be extraordinary. How far I have anſwered their Expectations, I know not; but this I know, that I have deſigned this Work not extraordinary abſtruſe or

profound,

profound, but have by all means possible within the Circumference of my Capacity, endeavoured to render it extraordinary useful to all those, whose Occasions shall induce them to make use of Numbers. If it be objected that the Books already published, treating of Numbers, are innumerable, I answer that's but a small wonder, since the Art is infinite. But that there should be so many excellent Tracts of Practical Arithmetick extant, and so little practised, is to me a greater wonder; knowing that as Merchandise is the Life of the Weal-Publick; so Practical Arithmetick is the Soul of Merchandise. Therefore I do ingenuously profess, that in the beginning of this undertaking, the numerous Concerns of the honoured Merchants first possessed my Consideration: And how far I have accommodated this Composure for his most worthy Service, let his own profitable experience be judge.

Secondly, For your Service, most excellent Professors, whose understandings soar to the sublimity of the Theory and Practice of this Noble Science, was this Arithmetical Tractate composed; which you may please to imploy as a Monitor to instruct your young Tyroes, *and thereby take occasion to reserve your precious moments, which might be exhausted that way, for your more important Affairs.*

Thirdly,

Thirdly, For you, the ingenious Off-spring of happy Parents, who will willingly pay the full Price of Industry and Exercise for those Arts and choice Accomplishments which may contribute to the Felicity of your future State. For you, I say, (ingenious Practitioners) was this Work composed, which may prove the Pleasure of your Youth, and the Glory of your Age.

Lastly, For you the pretended Numerists of this vapouring Age, who are more disingeniously witty to propound unnecessary Questions, than ingeniously judicious to resolve such as are necessary. For you was this Book composed and published, if you will deny your selves so much as to invert the streams of your ingenuity, and not studiously conferring with the Notes, Names, Orders, Progress, Species, Properties, Proprieties, Proportions, Powers, Affections and Applications of Numbers delivered herein, become such Artists indeed, as you now only seem to be. This Arithmetick ingeniously observed, and diligently practised, will turn to good account to all that shall be concerned in Accompts. All those Rules are grounded on verity and delivered with Sincerity. The Examples are built up gradually from the smallest consideration to the greatest. All the Problems or Propositions are well weighed, pertinent, and clear, and not one of them

them throughout the Tract taken upon truſt therefore now,

Zoilus and *Momus* lie you down and dye,
For theſe Inventions your whole force defye

Edward Cocker.

Courteou

Courteous Reader,

BEing well Acquainted with the deceaſed Author, and finding him knowing and ſtudious in the Myſteries of Numbers and Algebra, of which he had ſome choice Manuſcripts, and a great Collection of Printed Authors in ſeveral Languages. I doubt not but he hath writ his Arithmetick ſuitable to his own Preface, and worthy acceptation, which I thought to certifie on a requeſt to that purpoſe made to him that wiſheth thy Welfare, and the Progreſs of Arts.

John Collens.

November 27*th.* 1677.

This Manual of Arithmetick is recommended to the World by Us whoſe Names are ſubſcribed, viz.

Mr. *John Collens*, Mr. *James Atkinſon*, Mr. *Peter Perkins* } Matth.
Mr. *Rich. Laurence*, Senior
Mr. *Eleazer Wigan*
Mr. *Rich. Noble* of *Guilford*
Mr. *William Norgate*
Mr. *William Maſon*
Mr. *Steph. Thomas*
Mr. *Peter Storey*
Mr. *Benj. Tichbourn*
Mr. *Joſeph Symmonds*
Mr. *Jerem. Milles*
Mr. *Joſiah Cuſſley*
Mr. *John Hawkins*

And generally Approved by all Ingenious Artiſts.

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CHAP. I.

Notation of Numbers.

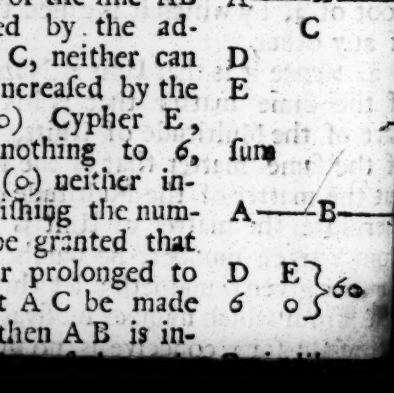
1. *Arithmetick* is an Art of Numbring or Knowledge, which teacheth to number well, (*viz.*) the Doctrine of Accounting by Numbers And there are divers Species and kinds of Arithmetick and Geometry, the which we do intend to treat of in order; applying the Principles of the one to the Definitions of the other: For as Magnitude or Greatneſs is the ſubject of Geometry, ſo Multitude or Number is the ſubject of Arithmetick; and if ſo, then their firſt Principles and chief Fundamentals, muſt have like Definitions; or at leaſt, a Semblable Congruency.

2. Number, is that by which the Quantity of any thing is Expreſſed or Numbred; as the Unit is the number by which the quantity of one thing is expreſſed or ſaid to be one, and two by which it is named two, and $\frac{1}{2}$ half by which it is named or called half, and the Root of 3, by which it is called the Root of 3, the like of any other.

3. Hence it is that Unit is Number, for the part is of the ſame matter that is his whole, the Unite is part of the Multitude of Units, therefore the Unit is of the ſame matter that is the Multitude of Units; but the matter of the Multitude of Units is number, therefore the matter of Unit is number; for elſe if from a given number, no number be ſubſtracted, the number given remaineth; let three be the number given, from which number ſubſtract or take away one (which as ſome conceive is no number) therefore the

number given remaineth, that is to say, there remaineth three, which is absurd.

4. Hence it will be convenient to examine from whence Number hath its Rise or Beginning: Most Authors maintain that Unit is the Beginning of Number, and it self no number; but looking upon the Principles and Definitions in the first rudiments of Geometry, we shall find, that the definition of a Point is in no way congruous with the Definition of an Unit in Arithmetick; and therefore one, or Unit must be in the bounds or limits of Number, and consequently the beginning of Number is not to be found in the number one; wherefore to make number and magnitude congruent in Principles, and like in Definitions, we make and constitute a Cypher to be the beginning of number, or rather the medium between encreasing and decreasing numbers, commonly called absolute or whole Numbers, and negative or fractional numbers, between which nothing can be imagined more agreeable to the definition of a point in Geometry; for as a point is an adjunct of a line, and it self no line, so is (o) Cypher an adjunct of number and it self no number: And as a point in Geometry cannot be divided or increased into parts; so likewise (o) cannot be divided or increased into parts; for as many points though in number infinite do make no line, so many (o) Cyphers, though in number infinite do make no number. For the line AB cannot be increased by the addition of the point C, neither can the number D be increased by the addition of the (o) Cypher E, for if you add nothing to 6, the Sum will be 6, (o) neither increasing nor diminishing the number 6, but if it be granted that A B be extended or prolonged to the point C, so that A C be made a continued line, then A B is in-



ner if we grant D 6 be prolonged to E (o) so that D E (60) be a continued number making 60, then 6 is augmented by the aid of (o) as to the constituting the number (60) sixty; and furthermore that one or unit is material and a number, and that (o) is the beginning of number is proved by all Authors altho' indirectly, for the Tables of Sines and Tangents prove one degree to be a number, because the Sine of 1 degree is 174524 (the Radius being 10000000) and the beginning of that Table is (o) and to it answereth 00000, *&c.*

5. Hence it is that number is not quantity discontinued, for all that which is but one quantity, is not quantiy disjunct; (60) sixty as it is a number, is one quantity, *viz.* one number (60) sixty; therefore as it is number, it is not quantity disjunct; for number, is some such thing in Magnitude, as humidity in Water; for as humidity extends it self through all and every part of Water, so number related to Magnitude, doth extend it self through all and every part of Magnitude. Also as to continued Water doth answer continued humidity, so to a continued Magnitude doth answer a continued number. As the continued Humidity of any intire Water, suffereth the same Division and Distinction that his Water doth; so the continued Number suffereth the same Division and Distinction that his Magnitude doth. From all which Considerations we might enlarge a further Digression concerning Number and Magnitude, by comparing the Definitions of the one with the Principles of the other, for having found a (o) Cypher to be answerable in Definition to a point in Magnitude, we may very well conclude that number may be congruent to a line; as also the Figurative Number to be consonant in Definition with a Superficies, and Solid, *&c.* in the order of Geometrical Magnitudes.

6. The Characters or Notes by which Numbers are signified, or by which a Number is ordinarily expressed, are these following, (*viz.*) o Cypher or nothing, 1 One, 2 Two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven

ſelf ſignifieth nothing (*viz.*) expreſſeth not any certain or known quantity, but is the Beginning, Radix, or Root of Number, and the other Nine Figures or Characters are called ſignificant Figures or Digits.

7. In Numbers of any ſort, two things are to be conſidered, (*viz.*) Notation and Numeration.

8. Notation teacheth how to deſcribe any Number by certain Notes and Characters, and to declare the value thereof being ſo deſcribed, and that is by Degrees and Periods.

9. A degree conſiſts of three figures, *viz.* of three places comprehending Units, Tens and Hundreds, ſo 365 is a degree, and the firſt figure (5) on the right hand, ſtands ſimply for its own value, being Units or ſo many ones (*viz.*) five; the ſecond in order from the right, ſignifies as many times ten, as there are unites contained in it, (*viz.*) ſixty; the third in the ſame order ſignifies ſo many hundreds as it contains Units, ſo will the expreſſion of the Number be, three hundred ſixty five; alſo 789, is ſeven hundred eighty nine, *&c.*

10. A Period is when a Number conſiſts of more than three figures, or places, and whoſe proper order is to prick or diſtinguiſh every third Place beginning at the right hand, and ſo on to the left; ſo the Number 63452 being given, it will be diſtinguiſhed thus 63.452, and expreſſed thus, ſixty three thouſand four hundred fifty two, likewiſe 4.578.236.782, being diſtinguiſhed, as you ſee will be expreſſed thus, four thouſand five hundred ſeventy eight Millions, two hundred thirty ſix thouſand, ſeven hundred eighty two.

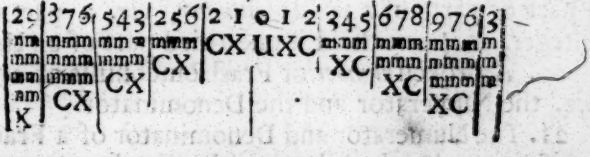
11. Number is either Abſolute or Negative.

12. An Abſolute, or intire, whole, increaſing Number, is that which by annexing of another Figure or Cypher it becomes ten times as much as it ſtood for before; and if two Figures or Cyphers be annexed, it makes it a hundred times more than it ſtood for before, *&c.* as if you annex to the Figure 6 a Cypher

annexed, then it will be (600) six hundred, and if you do annex to it a (4) four, then it will be (64) sixty four: and if you annex (78) seventy eight, it will be then (678) six hundred seventy eight, and so on: By annexing more Figures or Cyphers, it will encrease in a decuple proportion *ad Infinitum.*

13. A Negative, or Broken, Fractional, Decreasing Number, is that which by prefixing a Point or Prick towards the left hand its value is decreased from so many Units, to so many tenth parts of any thing; and if a point and (o) cypher, or a digit be prefixed, it will be then so many hundred parts, and if a Point and two Cyphers or digits be prefixed, its Value is decreased to be so many thousand parts; as if you would prefix before the Figure 3 a point (.) or prick thus (.3) it is then decreased from 3 Units or Integers, to (3) three tenth parts of an Unit or Integer; and if you prefix a point and cypher thus (.3) it is decreased from 3 Integers to 3 hundreth parts of an Integer, and by this means 5*l.* Absolute by prefixing of a point will be decreased to 5*l.* Negative which is five tenth parts of a Pound, equal in value to ten shillings, and so by prefixing of more Cyphers or Digits, its value is decreased in a decuple proportion *ad Infinitum.* As in the following Scheme, or rather order of Numbers, we have placed (o) Cypher in its due place and order, as it is both the beginning and medium of Number; for going from (o) towards the left hand you deal with Intire, Absolute, Whole increasing Numbers.

Increasing Numbers. | *Decreasing Numbers.*



But going from (o) the place of Units towards the right hand, you meet with broken, Negative, Fractional and Decreasing Numbers. And hence it follows that

Multiplication encreaſeth the product in Abſolute Numbers, but decreaſeth the product in Negative Numbers; Alſo Diviſion decreaſeth the Quotient in whole Numbers, and increaſeth it in Negative or Fractional Numbers.

14. An Abſolute, Intire, Whole, Increaſing *number*, hath always a point annexed towards the right hand, and therefore,

15. A Negative, Broken, Decimal, Decreaſing *number*, hath always a point prefixed before it towards the left hand. When we expreſs Integers or whole *numbers*, as 5 *pounds*, 5 *feet*, 26 *men*, we uſually annex a point or prick after the Number thus, 5. 5. 26. 347. But when we expreſs Decimals, or Numbers that are denyed to be intire, as decreaſing *Numbers*, we do commonly prefix a point or prick before the ſaid Decimal or decreaſing *number*, thus (.3) that is 3 tenths, or 3 primes .03, that is 3 hundredths, or 3 ſeconds.

l. feet men. inch.

16. A whole or abſolute *number* is an Unit or a compoſed Multitude of Units, and it is either a prime, or elſe a compounded *number*.

17. Prime *numbers* amongſt themſelves are thoſe which have no multitude of Units for a common meaſurer as 8 and 7 or 10 and 13, becauſe not any multitude of Units can equally meaſure or divide them without a Remainder.

18. Compound *numbers* amongſt themſelves are thoſe which have a multitude of Units for a common meaſurer, as 9 and 12, becauſe 3 meaſures them exactly, and abbreviates them to 3 and 4.

19. A Broken *number* commonly called a Fraction, is a part or parts of a whole *number*, *viz.* a part of an Integer, as $\frac{1}{3}$ one third is one third part of an Unit.

20. A Broken *number* or Fraction, conſiſts of 2 parts, *viz.* the Numerator and the Denominator.

21. The Numerator and Denominator of a Fraction, are ſet one over the other, with a line between them; and the Numerator is ſet above the line, and expreſſeth the parts therein contained.

The

22. The Denominator of a Fraction is the Inferior *number* placed below the line, and expreſſeth the number of parts into which the Unit or Integer is divided; as let $\frac{3}{4}$ be the Fraction given, ſo ſhall 3 be the numerator, and doth expreſs or *number* the multitude of parts contained in this Fraction, for $\frac{3}{4}$ is a Faction compoſed of Fourths or Quarters, and the Figure 3 in *numbring* ſhews us that in that Fraction there are 3 of thoſe fourth parts or quarters; alſo in the ſame Fraction $\frac{3}{4}$, 4 is the *denominator* and doth expreſs the Quality of the Fraction, *viz*, that the whole, or integer, is here divided into 4 equal parts,

23. A broken *number* is either Proper or Improper; *viz*. Proper, when the *numerator* is leſſer than the *denominator*; ſo $\frac{3}{8}$ is a perfect proper Fraction, but an improper Fraction hath its *numerator* greater or at leaſt equal to the *denominator*; thus $\frac{3}{3}$ is an improper Fraction, the Reaſon is given in the Definition.

24. A proper broken *number* is either *Simple*, or *Compound*; *viz*. *Simple*, when it hath one *Denomination*, and *Compound* when it conſiſteth of diverſe *Denominations*. If $\frac{3}{4}$ *l*., $\frac{6}{12}$., $\frac{25}{100}$ *l*. were given, we ſay they are either of them ſingle or *ſimple* Fractions becauſe they conſiſt but of one *numerator* and one *denominator*; but if $\frac{3}{4}$ of $\frac{9}{12}$ of $\frac{35}{100}$ of a pound ſterling were given, we ſay that it is a *compound broken number*, or *fraction*, becauſe the expreſſion and repreſentation conſiſteth of more *denominations* than one; and ſuch by ſome are called *Fractions of Fractions*, and they have always this Particle (of) between them.

25. When a ſingle *broken Number* or *Fraction*, hath for his *denominator* a *number* conſiſting of a Unit in the firſt place towards the left hand, and nothing but Cyphers from the Unit towards the right hand, it is then the more aptly and rightly called a decimal Fraction; under this head are all our decreaſing *numbers* placed, and in our 13*th definition* called Negative, and by that order there preſcribed, we order them to be *Decimals* by ſigning a point or prick before them, or the *numerator* rejecting the *denominator*: Therefore according

cording to our last Rule, $\frac{5}{10}$ $\frac{5}{100}$ $\frac{25}{100}$ $\frac{25}{1000}$ are said to be *Decimals*; and a *Decimal Fraction* may be expressed without its *denominator* (as before) by prefixing a point or prick before the *numerator* of the said *Fraction*, and then shall the former *Fraction* $\frac{5}{10}$ and $\frac{25}{100}$ stand thus .5 and .25.

But oftentimes as in the second and fourth fractions $\frac{5}{100}$ and $\frac{25}{1000}$, a prick or point will not do without the help of a Cypher or Cyphers prefixed before the significant figures of the *numerator*, and therefore when the *numerator* of a *decimal fraction*, consisteth not of so many places, as the *denominator* hath Cyphers, fill up the void places of the *numerator*, with prefixing Cyphers before the significant figures of the *numerator*, and then sign it for a *decimal*, so shall $\frac{5}{100}$ be .05 and $\frac{25}{1000}$ will be .025 and $\frac{72}{10000}$ will be .0072. Now by this we may easily discover the *denominator* having the *numerator*; for alwayes the denominator of any *decimal fraction* consists of so many Cyphers, as the *numerator* hath places, with a Unit prefixed before the said Cyphers, *viz.* under the point or prick.

26. A *Decimal Number* or *Fraction*, is that which is expressed by *Primes*, *Seconds*, *Thirds*, *Fourths*, &c. and is Number decreasing. Here instead of *Natural* and *Common Fractions*, as $\frac{3}{4}$ of a thing, we order the thing or Integer into *Primes*, *Seconds*, *Thirds*, *Fourths*, *Fifths*, &c. that our expression may be consonant to our former order.

27. In *Decimal Arithmetick*, we always imagin (and it would be very commodious if it were really so) that all intire Units, Integers, and things are divided first into ten equal parts, and these parts so divided we call *Primes*; and secondly, we divide also each of the former *Primes* into other ten equal parts, and every of these divisions we call seconds; and thirdly, we divide each of the said Seconds into ten other equal parts, and those so divided we call *Thirds* and so by decimating the former and sub-decimating these latter, we run on *ad infinitum*.

28. Let a pound sterling, Troy weight, Averdupois

pois weight, Liquid Measure, Dry measure, Long measure, time, dozen or any other thing, or Integer be given to be *decimally* divided; in this notion premised, we ought to let the first Division be *Primes*, the next division *Seconds*, the next *Thirds*, &c. So one pound Sterling being 20 shillings, which divided into ten equal parts, the value of each part will be two shillings; therefore one *Prime* of a Pound sterling will stand thus (.1) which is in value 2 shillings, Three *Primes* will stand thus (.3) and that is in value 6 shillings. Again a *Prime* or .1 being divided into ten equal parts, each of those parts will be one *Second*, and is thus expressed, (.01) and its Value will be found to be 2d. farthing and $\frac{6}{10}$ of a farthing; and so will .05 signifie one shilling, or five *Seconds*. And if .01 be divided into ten other equal Parts, each of those parts so divided will be *Thirds*, and will stand thus .001, and its Value will be found to be 96 of a Farthing, or $\frac{96}{100}$ of a Farthing; and .009 *Thirds* will be 2d. and .64 of a Farthing, or $\frac{64}{100}$ of a farthing, *&c.* So that .375 l. will be found to represent 7s. and 6d. for the 3 *Primes* are 6 shillings, and the 7 *Seconds* are 1s. 4d. and $\frac{8}{10}$ of a penny, and the five *Thirds* are 1 penny and $\frac{2}{10}$ of a penny, both which added together make 7s. 6d.

29. If you put any bulk or body, representing an Integer if it be *decimally divided*; then the parts in the first decimation are *Primes*, the next *Seconds*, and the next decimation is *Thirds*, the next *Fourths*, &c. As let there be given a Bullet of Lead, or such like, whose weight let be 50l. *Troy*, this call an Unit, Integer, or thing, then with the like weight and matter, make 10 other, the which together will be equal to 50 l. and will weigh each of them 5 l. a piece, take of the same matter, and equal to 5 l. make 10 more, then each of those will weigh 6 ounces a piece; also if again you take 6 ounces and thereof make 10 other small bullets each of them will weigh 12 penny weight *Troy*; and thus have you made *Primes*, *Seconds*, and *Thirds*, in respect of the Integer containing 50 l. *Troy* weight. So that 5 *Primes* is equal to the half mass, and 2 *Primes*

of the first division, 2 of the second division, and 5 of the third division, will be equal in weight to ½ a quarter of the mass, and contain 6 l. and 3 ounces.

30. When a *decimal Fraction* followeth a whole *number*, you are to separate or part the *decimal* from the *whole number*, by a point or prick ; so if .75 followed the *whole number* 32, set them thus 32.75. You will find that divers Authors have divers ways in expressing mixt *numbers*, as thus, $32\frac{75}{}$ or $32+\frac{75}{100}$ or 32.$\frac{75}{}$ but you will find that 32.75 thus placed and expressed is fittest for Calculation.

31. A mixt *Number* hath 2 parts, the whole and the broken; the whole is that which is composed of Integers, and the broken is a Fraction annexed thereunto. So the mixt *Number* $36\frac{8}{12}$ being given, we say that 36 is the whole *Number*, which is composed of Integers, and the $\frac{8}{12}$ is the broken *Number* annexed, which sheweth that one of the former Integers (of that 36) being divided into 12 parts, this $\frac{8}{12}$ doth express 8 of those 12 parts more belonging to the said 36 Integers.

32. *Denominative Numbers* are of one, or of many, and those are of divers sorts and kinds, *viz.* *Singular* called Unit, as 1; and *Plural* called multitude; as 2, 3, 4, 5, *Single* of one kind only, called *digits*, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and *Compounds* of many, as 10, 11, 12, *&c.* 102, 367, *&c.*

Proportional, as Single, Multiple, Double, Triple, Quadruple, *&c.* Denominate as Pounds, Shillings, Pence; Undenominate as 1, 2, 3, *&c.* Perfect is 6, 28, 496, 8128, 130816, 2096128, *&c.* Whose parts are equal to the numbers; imperfect, unequal and more in the sum, as 12 to 1, 2, 3, 4, 6. Imperfect, unequal and less than the sum, as 8 to 1, 2, 4. Numbers Commensurable and Incommensurable, as 12 and 9 are Commensurable because three measures them both.

But 6 and 17 are Incommensurable because no one common *Number* or *measure* can measure them; Linear in form of a line, as ..... Superficial in form of a Superficies or plane, as :::: ::: or ::: ::, *&c.* and numbers

number cubical or solid in form of a Cube. These two latter are otherwise called figurative numbers: There are also other numbers called Tabular, as Signs, Tangents, Secants, *&c.* Others that be called Logarithmetick or borrowed numbers, fitted to proportion for easie and speedy Calculation of all manner of Questions.

CHAP. II.

Of the Natural Division of Integers, and the several Denominations of the Parts.

1. BEfore we come to Calculation or the ordering of *Numbers* to operate any Arithmetical Question proposed, we will lay down Tables of the Denomination of several Integers; and after that (having mentioned the several Species or kinds of Arithmetick) we shall immediately handle the Species of Numeration, which are the main Pillars upon which the whole Fabrick of this Art is built.

Of Money, Weights, &c.

2. The least Denomination or Fraction of Money used in *England* is a Farthing, from whence is produced the following Tables, called the Table of Coyne, (*viz.*)

			And therefore,
1 *Farth.*		1 *Farthing*	l. s. d. qrs.
4 *Farth.*	make	1 *Penny*	1—20—12—4
12 *Pence*		1 *Shilling*	1—20·240·960
20 *Shil.*		1 *Pound*	1—12—48
			1—4

The first of these Tables, *viz.* that on the left hand is plain and easie to be understood, and therefore wants

no directions. In the ſecond Table above the line you have 1 *l.* 20 *s.* 12 *d.* 4 *qrs.* whereby is meant that 1 pound is equal to 20 ſhillings, and one ſhilling is equal to 12 pence, and one penny is equal to 4 Farthings, under the line is 1 *l* 20 *s.* 240 *d.* 960 *qrs.* which ſignifies one pound to contain 20 ſhillings, or 240 pence, or 960 Farthings; in the ſecond line below that is 1 *s.* 12 *d.* 48 *qrs.* the firſt ſtanding under the Denomination of Shillings, whereby is to be noted that one ſhilling is equal to 12 pence, or 48 Farthings, and likewiſe that below that, one penny is equal in value to four Farthings; underſtand the like reaſon in all the following Tables of Weight, Meaſure, Time, Motion and Dozen.

Of Troy Weight.

3. The leaſt Fraction or Denomination of weight uſed in *England*, is a grain of Wheat gathered out of the middle of the Ear, and well dryed; from whence are produced theſe following Tables of Weight, called *Troy weight.*

32 *Grains of Wheat*	make	24	*Artificial grains*
24 *Artificial Grains*		1	*Penny weight*
20 *Penny weight*		1	*Ounce*
20 *Ounces*		1	*Pound Troy weight*

And therefore,

l.	*oun.*	*p.w.*	*grains.*
1	12	23	24
			1
1	12	240	5760
	1	20	480
		1	24

Troy weight ſerveth only to weigh bread, gold, ſilver, and Electuaries; it alſo regulateth and preſcribeth a form how to keep the Money of *England* at a certain

ſtandard. The Goldſmiths have divided the Ounce *Troy weight* into other parts, which they generally call Mark weight; the denominative parts thereof are as followeth, *viz.* A Mark (being an ounce Troy) is divided into 24 equal parts, called Carects and each Carect into 4 grains, ſo that in a Mark are 96 Grains; by this weight they diſtinguiſh the different fineneſs of their Gold, for if to the fineſt of Gold be put 2 Carects of Alloy (which is of Silver, Copper, or other baſer Metal, with which they uſe to mix their gold or ſilver to abate the fineneſs thereof) both making when cold but an Ounce, or 24 Carects, then this Gold is ſaid to be 22 Carects fine, for if it come to be Refined the 2 Carects of Alloy will fly away and leave only 22 Carects of pure Gold, the like to be conſidered of a greater or leſſer quantity; and as the fineneſs of Gold is eſtimated by Carects, ſo the fineneſs of Silver is diſtinguiſhed by ounces; for if a pound of it be pure, and looſeth nothing in the Refining, ſuch ſilver is ſaid to be twelve ounces fine, but if it loſeth any thing, it is ſaid to contain ſo much fineneſs as the loſs wanteth of 12 ounces, as if it loſe an ounce it is ſaid to be 11 Ounces fine, and if it loſe one ounce 14 penny weight, then it is ſaid to be 10 ounces 6 penny weight fine, and that which loſeth 2 ounces 4 penny weight 16 grains is ſaid to be 9 ounces 15 penny weight 8 grains fine, *&c.* the like of a greater or leſſer quantity.

Of Apothecaries Weights.

4. The *Apothecaries* have their Weights deduced from Troy Weight, a pound *Troy*, being the greateſt Integer, a Table of whoſe diviſion and ſub-diviſion followeth, *viz.*

1 *pound*	makes	12 *ounces*	
1 *ounce*		8 *drams*	
1 *dram*		3 *ſcruples*	
1 *ſcrup.*		20 *grains*	

And therefore,

l.	*oun.*	*dram.*	*ſcrup.*	*gr.*
1	12	8	3	20
1	12	96	288	5760
	1	8	24	480
		1	3	60
			1	20

5. Thus much concerning *Troy weight*, and its derivative weights (which as was ſaid before) ſerveth to weigh Bread, Gold, Silver, and Electuaries; now beſides *Troy weight* there is another kind of weight uſed in *England*, commonly known by the name of *Averdupois* weight (a pound of which is equal to 14 ounces 12 penny weight *Troy-weight*) and it ſerveth to weigh all kinds of Grocery-Wares, as alſo Butter, Cheeſe, Fleſh, Wax, Tallow, Rozen, Pitch, Lead, and all ſuch kind of Garbel, the Table of which weight is as followeth.

The Table of Averdupois Weight.

4 *quarters of a dram*	make	1 *dram*	
16 *drams*		1 *ounce*	
16 *ounces*		1 *pound*	
28 *pounds*		1 *quarter of a hundr.*	
4 *quarters*		1 *hundr. weight, or* 112 *l.*	
20 *hundred*		1 *Tun*	

And therefore,

Tun	*C.*	*qrs.*	*l.*	*oun.*	*dra.*	*qrs.*
1	20	4	28	16	16	4
1	20	80	2240	35840	573440	2293760
	1	4	112	1792	28672	114688
		1	28	448	7168	28672
			1	16	256	1024
				1	16	64
					1	4

Wool is weighed with this Weight, but only the Diviſions are not the ſame; A Table whereof followeth.

A Table of the denominative Parts of Wool Weight.

7 *Pounds*	make	1 *Clove*	1 *Clove*
2 *Cloves*		1 *Stone*	1 *Stone*
2 *Stones*		1 *Todd*	1 *Todd*
6 *Todd* 1 *Stone*		1 *Wey*	
2 *Weyes*		1 *Sack*	
12 *Sacks*		1 *Laſt*	

And therefore

Last	*Sacks*	*Wey*	*Todd*	*Stone*	*Cloves*	*l.*
1	12	2	$6\frac{1}{2}$	2	2	7

1	12	24	156	312	624	4368
	1	2	13	26	52	364
		1	$6\frac{1}{2}$	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note that in some Countreys the *Wey* is 256 *l. Averdupois.* as is the *Suffolk Wey*; but in *Essex* there is 336 pound in a *Wey*.

6. The least Denominative part of Liquid measure is a pint, which was formerly taken from *Troy weight*, (a pound of Wheat *Troy weight* making 1 pint of liquid measure) but in regard of the difference between the Brewers and the Farmers of his Majesty's Excise concerning the gauging of Vessels occasioned by the different Opinions of Artists, concerning the solid Inches in a Gallon; it was lately decided by Act of Parliament, the Statute making 282 solid Inches in a Beer-Gallon, and 231 in a Wine-Gallon, and consequently the Pint Beer-Measure to contain $35\frac{1}{4}$ solid Inches, and the Pint Wine-measure to contain $28\frac{7}{8}$ cubical or solid Inches, from whence is drawn the following Table.

The Table of Liquid Measure.

$35\frac{1}{4}$ *cubical Inch*	1 *pint beer measure*
$28\frac{7}{8}$ *cubical Inch*	1 *pint wine measure*
2 *pints*	1 *quart*
2 *quarts*	1 *pottle*
2 *pottles*	1 *gallon*
8 *gallons*	1 *firk. of ale, soap, or herr.*
9 *gallons*	1 *firk. of beer*
10 *gall. and a half*	1 *firk. of Salmon or Eels*
2 *firkins*	1 *Kilderkin*
2 *kilderkins*	1 *Barrel*
42 *gallons*	1 *Tierce of wine*
63 *gallons*	1 *hogshead*
2 *hogsheads*	1 *pipe or butt*

And therefore,

Tuns	*pipes*	*hhds*	*gal.*	*pts.*
1	2	2	63	8
1	2	4	252	2016
	1	2	126	1008
		1	63	504
			1	8
				1

7. The leaſt Denominative part of dry meaſure is alſo a pint, and this is likewiſe taken from *Troy weight*. The Table of whoſe diviſion followeth.

The Table of Dry Meaſure.

1 *pint*	make	1 *pint*
2 *pints*		1 *quart*
2 *quarts*		1 *pottle*
2 *pottles*		1 *gallon*
2 *gallons*		1 *peck*
4 *pecks*		1 *buſhel*
4 *buſhels*		1 *Comb*
2 *Combs*		1 *quarter*
4 *quarters*		1 *Chaldron*
5 *quarters*		1 *Wey*
2 *Weys*		1 *Laſt*

And therefore,

laſt	*wey*	*qrs.*	*com.*	*buſh.*	*peck*	*gall.*	*pints*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	640	5120
1	2	10	40	160	320	2560	
1	2	8	32	64	512		
1	4	16	32	256			
1	4	8	64				
1	2	16					
1	8						

8. The least Denominative part of *Long Measure* is a Barley-Corn well dryed and taken out of the middle of the Ear; whose Table of parts followeth.

The Table of Long Measure.

3 *barley corns*	make	1 *inch*
12 *inches*		1 *foot*
3 *Feet*		1 *yard*
3 *feet 9 inches or yard and quart.*		1 *Ell English*
6 *feet*		1 *fathom*
5 *yards and an half*		1 *pole or perch*
40 *poles or perches*		1 *furlong*
8 *furlongs*		1 *English mile*

And therefore,

mile	*furl.*	*poles*	*yards*	*feet*	*inches*	*barl.corns*
1	8	40	$5\frac{1}{2}$	3	12	3
1	8	320	1760	5280	63360	190080
	1	40	220	660	7920	23760
		1	$5\frac{1}{2}$	$16\frac{1}{2}$	198	594
			1	3	36	108
				1	12	36
					1	3

And note that the yard as also the ell, is usually divided into 4 quarters, and each quarter into 4 Nails.

Note also that a Geometrical Pace is 5 feet; and there are 1056 such Paces in an *English* mile.

2. The parts of the Superficial measures of land are such as are mentioned in the following Table, *viz.*

The Table of Land Measure.

40 *Square Poles or Perches*	make	1 *Rood or quarter of an Acre.*
4 *Roods*		1 *Acre.*

By

By the foregoing Table of long Measure, you are informed what a pole, or (which is all one) perch is; and by this that 40 square perches are 1 Rood. Now a square perch is a Superficies very aptly resembled by a square Trencher, ever side thereof being a Perch or 5 Yards and a half in length, 40 of them is a Rood, and 4 Roods an Acre. So that a Superficies that is 40 perches long and 4 broad is an Acre of Land, the Acre containing in all 160 square Perches.

10. The least denominative part of Time is a Minute, the greatest Integer being a Year; from whence is produced this following Table.

The Table of Time.

1 *Minute*			1 *Minute*
60 *Minutes*			1 *Hour*
24 *Hours*			1 *Day natural*
7 *Days*		make	1 *Week*
4 *Weeks*			1 *Month*
13 *Months* 1 *day & 6 hours*			1 *Year*

But the Year is usually divided into 12 unequal Kalendar Months, whose names and the number of Days that they contain follow, *viz.*

	days
January	31
February	28
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

So that the Year containeth 365 Days, and 6 Hours, but the 6 Hours is not reckoned but only every 4*th.* year, and then there is a day added to the latter end of *February*, and then it containeth 29 days, and that year is called Leap-year, and containeth 366 days.

And here note that as the Hour is divided into 60 Minutes, so each Minute is subdivided into 60 *Seconds*, and each *Second* into 60 *Thirds*, and each *Third* into 60 *Fourths*, &c.

The Tropical Year by the exactest observations of the most accurate Astronomers is found to be 365 Days, 5 Hours, 49 Minutes, 4 *Seconds*, and 21 *Thirds*.

CHAP. III.

Of the Species or Kinds of Arithmetick.

1. ARithmetick is either Natural, Artificial, Analytical, Algebraical, Lineal or Instrumental.

2. Natural Arithmetick is that which is performed by the Numbers themselves; and this is either Positive or Negative. *Positive* which is wrought by certain infallible numbers propounded, and this is either Single or Comparative; Single which considereth the nature of *numbers* simply by themselves; and Comparative, which is wrought by *numbers* as they have Relation one to another. And the Negative part relates to the Rule of *False*.

3. Artificial (by some called Logarithmetical) Arithmetick is that which is performed by Artificial or borrowed *numbers* invented for that purpose, and are called Logarithms.

4. Analytical Arithmetick, is that which shews from a thing unknown to find truly that which is sought; always keeping the Species without Change.

5. Algebraical Arithmetick is an obscure and hidden Art of Accompting by numbers in resolving of hard Questions.

6. Lineal Arithmetick, is that which is performed by fitted lines to proportions, as Geometrical projections.

7. Instrumental Arithmetick, is that which is performed by Instruments fitted with Circular and Right lines of Proportion, by the Motion of an Index or otherwise.

8. The

8. The parts of ſingle Arithmetick are Numeration and the Extraction of Roots.

9. Numeration is that which by certain known numbers propounded, we diſcover another number unknown.

10. Numeration hath four Species; *viz.* Addition, Subſtraction, Multiplication, and Diviſion.

CHAP. IV.

Of Addition of whole Numbers.

1. ADdition is the Reduction of two, or more *numbers* of like kind together into one Sum or Total. Or it is that by which divers *numbers* are added together, to the end that the Sum or Total value of them all may be diſcovered.

The firſt *number* in every addition is called the Addible *number*, the other, the *number* or *numbers* added, and the *number* invented by the Addition is called the *Aggregate* or *Sum* containing the value of the *Addition*.

The Collation of the *numbers*, is the right placing of the *numbers* given reſpectively to each denomination, and the Operation is the Artificial adding of the *numbers* given together in order to the finding out of the *Aggregate* or Sum.

2. In Addition, place the *Numbers* given reſpectively the one above the other, in ſuch ſort, that the like degree, place or denomination, may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, *&c.*

3. Having thus placed the *numbers* given (as before) and drawn a line under them, add them together, beginning with the leſſer Denomination, *viz.* at the right hand and ſo on, ſubſcribing the ſum under the line Reſpectively; as for Example.

Let there be given 3352 and 213 and 133 to be added together, I ſet the Units in each particular *number* under each other, and ſo likewiſe the Tens under the Tens, *&c.* and draw a line under them as in the Margent, then I begin at the place of Units and add them together upwards, ſaying, 3 and 3 are 6 and 2 make 8 which I ſet under the line, and under the ſame Figures added together; then I proceed to the next place, being the place of Tens, and add them up in the ſame manner as I did the place of Units, ſaying 3 and 1 are 4 and 5 are 9, which I likewiſe ſet under the line reſpectively; then I go to the place of Hundreds, and add them up as I did the other, ſaying 1 and 2 are 3 and 3 are 6, which I alſo ſet under the line; and laſtly I go to the place of Thouſands, and becauſe there are no other figures to add to the 3, I ſet it under the line in its reſpective place, and ſo the work is finiſhed; and I find the ſum of the 3 given Numbers to be 3698.

3352
213
133
3698

4. But if the Sum of the Figures of any Series exceeds ten, or any *number* of tens, ſubſcribe under the ſame the Exceſs above the tens, and for every ten carry one to be added to the next Series towards the left hand, and ſo go on until you have finiſhed your addition; always remembring, that how great ſoever the ſum of the Figures of the laſt Series is, it muſt all be ſet down under the line reſpectively. So 3678 being given to be added to 2357, I ſet them down as is before directed, and as you ſee in the Margent with a line drawn under them, then I begin and add them together, ſaying 7 and 8 are 15, which is five above 10, wherefore I ſet 5 under the line and carry 1 for the 10 to be added to the next Series, ſaying 1 that I carried and 5 is 6 and 7 are 13, wherefore I ſet down 3 and carry 1 (for the ten) to the next Series, then I ſay 1 that I carried and 3 are 4 and 6 are 10, now becauſe it comes to juſt 10 and no more, I ſet 0 under the line and carry 1 for the 10 to the next, and ſay, 1

3678
2357
6035

that I carried and 2 are 3 and 3 are 6, which I ſet down in its Reſpective place, thus the addition is ended, and the total Sum of theſe *numbers* is found to be 6035, ſeveral Examples of this kind follow.

Numbers to be added	354867 573846 785946 347205
Sum	2061864

Numbers to be added	748647 465834 76483 648300
Sum	1939264

Numbers to be added	45348 38074 8437 923 76
Sum	92856

5. If the Numbers given to be added, are contained under divers denominations; as of Pounds, Shillings, Pence and Farthings; or of Tuns, Hundreds, Quarters, *Pounds*, *&c.* Then in this caſe having diſpoſed of the *Numbers*, each Denomination under other of like kind; beginning at the leaſt Denomination, (minding how many of one denomination do make an Integer in the next) and having added them up, for every Integer of the next greater denomination that you find therein contained, bear an Unit in mind to be added to the ſaid next greater denomination, expreſſing the exceſs reſpectively under the line, proceed in this manner until your addition be finiſhed; the following Examples will make the Rule plain to the Learner. Thus theſe ſeveral ſums being given to be added, *viz.* 136 *l.* 13 *s.* 4 *d.* 2 *qrs.* and 79 *l.* 07 *s.* 10 *d.* 3 *qrs.* and 33 *l.* 18 *s.* 09 *d.* 1 *qr.* alſo 15 *l.* 09 *s.* 07 *d.* 00 *qrs.* The *Numbers* being diſpoſed according to order will ſtand as in the Margent.

and add them up, saying 1 and 3 are 4 and 2 make 6, now I consider that 6 Farthings is 1 penny, and 2 Farthings, wherefore I set down the 2 Farthings in its place under the line, and keep 1 in mind to be added to the next denomination of Pence; then I go on, saying 1 that I carried and 5 are 6 and 9 are 15 and 10 are 25 and 4 are 29, now I consider that 29 pence are 2 shillings and 5 pence, wherefore I set the 5 pence in order under the line and keep 2 in mind for the 2 shillings, to be added to the shillings; then I go on, saying, 2 that I carried and 9 are 11; and 18 are 29, and 7 are 36, and 13 are 49; then I consider that 49 shillings are 2 pounds and 9 shillings, wherefore I set the 9 shillings under the line, and carry two for the 2 pounds, to the next and last denomination of pounds, and proceed, saying 2 that I carried and 5 make 7, and 3 are 10, and 9 are 16, and 6 are 25; I then set down 5 and carry 2 for the 2 tens, and proceed, saying, 2 that I carry and 1 is 3, and 3 are 6, are 7 are 13, and 3 make 16; I set down 6 and carry 1 for the 10, and go on, saying 1 that I carried and 1 are 2, which I set in its place under the line, and the work is finished; and thus I find the Sum of the foresaid *Numbers* to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* This to the ingenious Practitioner is sufficient, but I shall (for the further illuminating of weaker apprehensions) explain the operation of another Example in *Troy weight*; and here the Learner must take notice of the Table of *Troy weight* mentioned or set down in the third Section of the second Chapter. The *numbers* given in this Example are 38 *l.* 7 *oz.* 13 *p.w.* 18 *gr.* And 50 *l.* 10 *oz.* 10 *p.w.* 12 *gr.* And 42 *l.* 08 *oz.* 05 *p.w.* 16 *gr.* And in order to the Addition thereof, I place them as you see, and proceed to operation; saying, 16 and 12 are 28, and 18 are 46; now because 24 *grains* make

l.	s.	d.	qrs.
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2

1 *penny weight*, 46 *grains* are 1 *penny weight* and 22 *grains*; wherefore I set down 22, and carry 1 for the *penny weight*, and going on, I say, 1 that I carry and 5 make 6, and 10 are 16, and 13 are 29, which is one ounce and 9 *penny weight*, I set down 9 in its place under the line, and carry 1 to the ounces, saying 1 that I carry and 8 are 9, and 10 are 19, and 7 are 26, and because 26 *ounces* make 2 *pound* 2 *ounces*, I set down 2 for the *ounces*, and carry 2 to the *pounds*; going on, 2 that I carry and 2 are 4, and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5, and 5 are 10, and 3 are 13, which I set down as in the Margent, and the work is finished, and I find the sum of the said *numbers* to amount to 132*l.* 2 *oz.* 9 *p.w.* 22 *gr.* This is sufficient for the understanding of the following Examples, or any other that shall come to thy View. The Way of proving these or any Sums in this Rule is shewed immediately after the ensuing Examples.

l.	*oz.*	*p.w.*	*gr.*
38	07	13	18
50	10	10	12
42	08	05	16
132	02	09	22

Addition of English Money.

l.	*s.*	*d.*	*qrs.*
436	12	07	1
184	09	10	3
768	17	04	2
564	11	11	0
1954	12	09	2

l.	*s.*	*d.*	*qrs.*
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
168	06	10	1

Addition of Troy Weight.

l.	*oz.*	*p.w.*	*gr.*
15	07	13	12
18	06	04	20
11	10	16	18
09	04	10	22
19	11	18	04
22	00	00	00
97	05	04	04

l.	*oun.*	*p.w.*	*gr.*
145	09	12	18
726	08	14	10
380	07	06	13
83	10	16	20
130	00	10	12
74	07	15	00
			10
1541	08	16	00

Addition of Apothecaries Weights.

l.	*oun.*	*dr.*	*scr.*	*gr.*
48	07	1	0	14
74	05	5	2	10
64	10	7	1	16
17	08	1	0	11
34	09	6	1	09
240	05	6	1	00

l.	*oun.*	*dr.*	*scr.*	*gr.*
60	03	4	0	10
48	10	6	0	14
34	08	2	1	15
18	11	2	2	11
160	07	1	2	15
35	02	5	1	07
358	07	7	0	12

Addition of Averdupois weight.

Tun	*C.*	*qrs.*	*l.*
75	13	1	15
48	07	3	21
60	11	1	17
21	07	0	25
12	16	0	11
218	16	0	05

l.	*oun.*	*dr.*
36	10	12
22	11	13
11	07	04
15	04	10
20	00	09
106	03	00

Addition of Liquid Measure.

Tun	*Pipe*	*hhd.*	*gall.*
45	1	1	48
15	0	1	17
38	0	0	47
12	1	0	56
21	1	1	18
133	1	1	60

Tuns	*hhds.*	*gall.*	*pts.*
30	3	40	4
12	0	28	6
47	5	60	5
57	3	22	3
17	0	00	0
166	1	26	2

Addition of Dry Measure.

Chald.	*qrs.*	*bush.*	*pec.*
48	3	7	3
13	1	4	0
54	0	6	2
16	3	6	1
40	1	0	1
173	3	0	3

qrs.	*bush.*	*pec.*	*gall.*
17	3	1	1
50	1	3	0
14	5	3	1
40	2	0	1
30	0	3	0
152	5	3	1

Addition of Long Measure.

yds.	*qrs.*	*na.*
35	3	3
14	1	2
74	2	3
38	0	1
30	1	0
15	0	0
218	1	1

ells.	*qrs.*	*na.*
56	1	3
13	3	2
48	2	1
50	1	0
74	0	2
17	1	0
260	2	0

Addition of Land Measure.

Acre	*Rood*	*perc.*
12	3	18
14	0	24
30	2	19
48	3	30
28	1	38
50	3	26
185	3	35

Acre	*Rood*	*perc.*
86	1	36
47	3	24
73	2	18
60	0	07
04	2	08
14	1	14
286	3	27

The Proof of Addition.

6. *Addition* is proved after this manner, when you have found out the ſum of the Numbers given, then ſeparate the uppermoſt line from the reſt, with a ſtroke or daſh of the pen, and then add them all up again as you did before, leaving out the uppermoſt line, and having ſo done add this new invented ſum to the uppermoſt line you ſeparated, and if the ſum of thoſe 2 lines be equal to the ſum firſt found out, then the work was performed true, otherwiſe not: As for Example, let us prove the firſt Example of *Addition* of Money whoſe ſum we found to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* and which we prove thus, having ſeparated the uppermoſt number from the reſt, by a line as you ſee in the Margent, then I add the ſame together again, leaving out the ſaid uppermoſt line, and the ſum thereof I ſet under the firſt ſum or true ſum, which doth amount to 128 *l.* 16 *s.* 01 *d.* 2 *qrs.* then again I add this new Sum to the uppermoſt line that before was ſeparated from the reſt, and the ſum of theſe two is 265 *l.* 09 *s.* 05 *d.* 2 *qrs.* the ſame with the firſt Sum, and therefore I conclude that the Operation was rightly performed.

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	01	0
265	07	05	2

7. The main end of *Addition* in Queſtions Reſolvable thereby, is to know the ſum of ſeveral Debts, Parcels, Integers, *&c.* Some Queſtions may be theſe that follow.

Queſt. 1. There was an old Man whoſe age was required, to which he replyed, I have ſeven Sons, each having two years between the birth of each other, and in the 44 year of my age my eldeſt Son was born, which is now the age of my youngeſt; I demand

Now to resolve this Question, first set down the Fathers age at the birth of his first Child, which was 44, then the difference between the eldest and the youngest, which is 12 years, and then the age of the youngest which is 44, and then add them all together, and their sum is 100 the compleat Age of the Father.

	44
	12
	44
	100

Quest. 2. A Man lent his Friend, at several times, these several Sums, (*viz.*) at one time 63 *l.* at another time 50 *l.* at another time 48 *l.* at another time 156 *l.* now I desire to know how much was lent him in all.

Set the Sums lent one under another, as you see in the Margent, and then add them together, and you will find their Sum to amount to 317 *l.* which is the Total of all the several Sums lent, and so much is due to the Creditor.

	63
	50
	48
	156
	317

Quest. 3. From *London* to *Ware* is 20 miles, thence to *Huntington* 29 miles, thence to *Stamford* 21 miles, thence to *Tuxford* 36 miles, thence to *Wentbridge* 25 miles, from thence to *York* 20 miles. Now I desire to know how many miles it is from *London* to *York* according to this reckoning.

Now to answer this Question, set down the several distances given, as you see in the Margent, and add them together, and you will find their Sum to amount to 151, which is the true Distance in miles between *London* and *York*.

	20
	29
	21
	36
	25
	20
	151

Quest. 4. There are two numbers, the least whereof is 40, and their Difference is 14, I desire to know what is the greater number, and also what is the Sum of them both? First, set down the least, *viz.* 40, and 14 the difference, and add them together, and their sum is 54 for the greatest number,

	40
	14
greatest	54
least	40
Sum	94

then I ſet (40 the leaſt) under 54 (the greateſt) and add them together, and their Sum is 94 equal to the greateſt and leaſt numbers.

CHAP. V.

Of Subſtraction of whole Numbers.

1. *Subſtraction* is the taking of a leſſer number out of a greater of like kind, whereby to find out a third number, being or declaring the inequality, exceſs, or difference between the numbers given; or *Subſtraction* is that by which one number is taken out of another number given, to the end that the reſidue or remainder may be known, which remainder is alſo called the *Reſt*, *Remainder*, or *Difference* of the numbers given.

2. The number out of which *Subſtraction* is to be made, muſt be greater, or at leaſt equal with the other Number given; the higher or ſuperiour number is called the major number, and the lower or inferior is called the minor number, and the operation of *Subſtraction* being finiſhed, the Reſt or Remainder is called the Difference of the Numbers given.

3. In *Subſtraction* place the Numbers given reſpectively, the one under the other, in ſuch ſort as like degrees, places, or denominations may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, *&c.* Pounds under Pounds, *&c.* Feet under Feet, and Parts under Parts, *&c.* This being done, draw a line underneath, as in *Addition.*

4. Having placed the Numbers given as is before directed, and drawn a line under them, ſubſtract the lower Number (which in this caſe muſt alwayes be leſſer than the uppermoſt) out of the higher number, and ſubſcribe the difference, or remainder reſpectively below the line; and when the Work is finiſhed, the

number below the line will give you the Remainder: As for Example, let 364521 be given to be ſubſtracted from 795836, I ſet the leſſer under the greater as in the Margent, and draw a line under them, then beginning at the Right hand, I ſay 1 out of 6 and there remains 5, which I ſet in order under the line; then I proceed to the next, ſaying 2 from 3 reſts 1, which I note alſo under the line, and thus I go on until I have finiſhed the Work; and then I find the Remainder or Difference to be 431315.

795836
364521
431315

5. But if it ſo happen (as commonly it doth) that the lowermoſt number or figure is greater than the uppermoſt; then in this caſe add ten to the uppermoſt number, and ſubſtract the ſaid lowermoſt number from their Sum, and the remainder place under the Line, and when you go to the next Figure below, pay an Unit by adding it thereto for the ten you borrowed before, and ſubſtract that from the higher number or figure: And thus go on until your Subſtraction be finiſhed. As for Example, Let 437503 be given, from whence it is required to ſubſtract 153827, I diſpoſe of the numbers as is before directed, and as you ſee in the margent; then I begin, ſaying 7 from 3 I cannot, but (adding 10 thereto I ſay) 7 from 13 and there remains 6 which I ſet under the Line in order; then I proceed to the next Figure, ſaying 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remains 7, which I likewiſe ſet down as before; then 1 that I borrowed and 8 is 9 from 5 I cannot, but 9 from 15 and there remains 6; then 1 I borrowed and 3 is 4, from 7 and there remains 3; then 5 from 3 I cannot, but 5 from 13 and there remains 8; then 1 I borrowed and 1 are 2, from 4 and there reſts 2: And thus the Work is finiſhed; and after theſe numbers are ſubſtracted one from another, the Inequality, Remainder, Exceſs or Difference is found to be

437503
153827
283676

283676. Examples for thy further Experience may be these that follow.

From	3475016	*From*	3615746
Take	738642	*Take*	5864
Rests	2736374	*Rests*	3609882

6. If the *Sums* or *Numbers* to be *Substracted*, are of several Denominations, place the lesser *Sum* below the greater, and in the same rank and order as is shewed in Addition of the same *Numbers*; then begin at the Right hand and take the lower *number* out of the uppermost if it be lesser; but if it be bigger than the uppermost, then borrow an Unit from the next greater Denomination, and turn it into the Parts of the lesser Denomination, and add those parts to the uppermost Number, and from their *Sum* substract the lowermost, noting the remainder below the Line; then proceed and pay 1 to the next Denomination for that which you borrowed before, and proceed in this order until the work be finished. An Example of this Rule may be this that followeth, let 375 *l.* 13 *s.* 07 *d.* 1 *qr.* be given, from whence let it be required to *substract* 57 *l.* 16 *s.* 03 *d.* 2 *qrs.* In order whereunto I place the numbers as you see in the Margent, and thus I begin at the least Denomination, saying two from one I cannot, therefore I borrow one penny from the next Denomination and turn it into Farthings, which is 4, and adding 4 to 1 which is 5, I say, but 2 from 5 and there remains 3, which I put under the line; then going on, I say, 1 that I borrowed and 3 is 4, from 7 and there rests 3; then going on, I say 16 from 13 I cannot, but (borrowing one pound and turning it into 20 shillings, I add it to 13, and that is 33) wherefore I say, sixteen from 33, and there remains 17, which I set under the line and go on, saying 1 that I borrowed and 7 is 8, from 5 I cannot, but 8 from 15 and there remains 7; the one that I

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3

borrowed and 5 is 6, from 7 there reſts 1, and 0 from 3 reſts 3, and the work is done: And I find the remainder or difference to be 317 *l.* 17 *s.* 03 *d.* 3 *qrs.*

Another Example of *Troy-weight* may be this, I would ſubſtract 17 *l.* 10 *oz.* 11 *p.w.* 20 *gr.* from 24 *l.* 05 *oz.* 00 *p.w.* 08 *gr.* I place the Numbers according to the Rule, and begin, ſaying 20 from 8 I cannot, but borrow 1 *penny weight*, which is 24 *grains*, and add them to 8, and they are 32, wherefore I ſay 20 from 32 reſt 12; then 1 that I borrowed and 11 is 12, from 00 I cannot, but 12 from 20 (borrowing an Ounce which is 20 *penny weight*) and there remain 8; then 1 that I borrowed and 10 is 11, from 5 I cannot, but 11 from 17 and there reſts 6; then 1 that I borrowed and 7 is 8, from 4 I cannot, but 8 from 14 and there reſt 6; then 1 that I borrowed and 1 is 2 from 2 and there reſts nothing; ſo that I find the Remainder or difference to be 6 *l.* 6 *oz.* 8 *p.w.* 12 *gr.*

l.	*oz.*	*p.w.*	*gr.*
24	05	00	08
17	10	11	20
06	06	08	12

7. It many times happeneth that you have many *Sums* or *Numbers* to be *ſubſtracted* from one *number*; as ſuppoſe a Man ſhould lend his Friend a certain ſum of Money, and his Friend had paid him part of his Debt at ſeveral times, then before you can conveniently know what is ſtill owing, you are to add the ſeveral *Numbers* or *Sums* of Payment together, and *ſubſtract* their *Sum* from the whole Debt, and the Remainder is the *Sum* due to the Creditor, as ſuppoſe A lendeth to B 564 *l.* 13 *s.* 10 *d.* and B. hath repaid him 79 *l.* 16 *s.* 08 *d.* at one time, and 163 *l.* 18 *s.* 11 *d.* at another time, and 241 *l.* 15 *s.* 08 *d.* at another time; and you would know how the Accompt ſtandeth between them, or what more is due to A. In order whereunto

	l.	*s.*	*d.*
Lent	564	13	10
Paid at ſeveral payments	79	16	08
	163	18	11
	241	15	08
paid in all	485	11	03
Remains	79	02	07

I first set down the *Sum* which A lent, and draw a line underneath it, then under that line set the several *Sums* of payment as you see in the Margent; and having brought the several Sums of payment into one Total by the fifth Rule of the fourth Chapter foregoing, I find their *Sum* amounteth to 485 *l.* 11 *s.* 3 *d.* which I substract from the *Sum* first lent by A, by the sixth Rule of this Chapter, and I find the Remainder to be 79 *l.* 2 *s.* 7 *d.* And so much is still due to A.

When the Learner hath good knowledge of what hath been already delivered in this and the foregoing Chapter, he will with ease understand the manner of working the following Examples.

Substraction of whole Money.

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	374	10	03	700	10	11	2
Paid	79	15	11	9	03	11	3
Remains	304	14	04	691	06	11	3

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	1000	00	00	711	03	00	0
Paid	19	00	06	11	13	00	1
Rem. due	980	19	06	699	09	11	3

Borrowed	3300	00	00	0
Paid at several payments	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remain due	2 01	07	09	1

Subſtraction of Troy Weight.

	l.	oz.	pw:	gr.
Bought	174	00	13	00
Sold	78	04	16	15
Remains	95	07	16	09

	l.	oz.	p.w.	gr.
Bought	470	10	13	00
Sold at ſeveral Times	60	00	00	00
	35	10	18	00
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Rem. unſold	225	00	05	17

Subſtraction of Apothecaries Weights.

	l.	oz.	dr.	ſcr.	gr.	l.	oz.	dr.	ſcr.	gr.
Bought	12	04	3	0	00	20	00	1	0	07
Sold	8	05	1	1	15	10	00	1	2	12
Remains	3	11	1	1	05	9	11	7	0	15

Subſtraction of Averdupois Weight.

	C.	qrs.	l.	Tun	C.	qrs.	l.	oz.	dr.
Bought	25	0	15	5	07	1	10	10	05
Sold	16	2	20	3	17	1	16	09	13
Remains	18	2	20	1	09	3	22	00	08

Subſtraction of Liquid Meaſure.

	Tun	hhd.	gall.	Tun	hhd.	gall.	pec.
Bought	40	1	30	60	3	42	4
Sold	16	1	40	15	3	46	6
Remains	23	3	53	44	3	58	6

Subſtraction of Dry Meaſure.

	Chal.	qrs.	buſh.	pec.	Chal.	qrs.	buſh.	pec.
Bought	100	0	00	0	73	2	3	2
Sold	54	1	04	3	46	2	3	3
Remains	45	2	03	1	26	3	7	3

Subſtraction of Long Meaſure.

	yards	qrs.	nails	yards.	qrs.	nails
Bought	160	1	0	344	0	1
Sold	64	1	2	177	1	3
Remains	95	3	2	166	2	2

Subſtraction of Land Meaſure.

	Acres	rood	per.	Acres	rood	per.
Bought	140	2	13	600	0	00
Sold	70	3	22	54	0	16
Remains	69	2	31	545	3	24

The Proof of Subſtraction.

8. When your *Subſtraction* is ended, if you deſire

to prove your work, whether it be true or no, then add the remainder to the minor *Number*, and if the *Aggregate* of theſe two be equal to the major *Number*, then is your Operation true, otherwiſe falſe; thus let us prove the firſt *Example* of the fifth Rule of this *Chapter*, where after *Subſtraction* is ended, the *Numbers* ſtand as in the *Margent*; the Remainder or difference being 283676. Now to prove the work, I add the ſaid Remainder 283676 to the minor number 153827, by the fourth Rule of the foregoing Chapter, and I find the Sum or *Aggregate* to be 437503 equal to the major Number, or Number from whence the leſſer is *ſubſtracted*; behold the work in the *Margent*.

437503	
153827	
283676	
437503	
153827	
283676	
437503	

The Proof of another *Example* may be of the firſt *Example* of the ſixth *Rule* of this *Chapter*, where it is required to *ſubſtract* 57 *l.* 16 *s.* 03 *d.* 2 *qrs.* from 375 *l.* 13 *s.* 07 *d.* 1 *qr.* and by the *Rule* I find the *Remainder* to be 317 *l.* 17 *s.* 03 *d.* 3 *qrs.* now to prove it, I add the ſaid *Remainder* 317 *l.* 17 *s.* 03 *d.* 03 *qrs.* to the minor *number* 57 *l.* 16 *s.* 03 *d.* 02 *qrs.* and their ſum is 375 *l.* 13 *s.* 07 *d.* 1 *qr.* equal to the major *number*, which proves the work to be true, but if it had happened to have been either more or leſs than the ſaid major *number*, then the *operation* had been falſe.

l.	*s.*	*d.*	*qrs.*
365	13	07	1
57	16	03	2
317	17	03	3
375	13	07	1

9. The general effect of *Subſtraction* is to find the differences or exceſs between two *numbers*, and the reſt when a payment is made in part of a greater Sum, the date of Books printed, the age of any thing by knowing the preſent year, and the year wherein they were made, created or built, and ſuch like.

The Queſtions appropriated to this Rule are ſuch as follow.

Queſt. 1. What difference is there between one thing of 125 foot long and another of 66 foot long?

To reſolve this Queſtion, I firſt ſet down the major or greater *number* 125, and under it the minor or leſſer *number* 66, as is directed in the third *Rule* of this Chapter, and according to the fourth Rule of the ſame I *ſubſtract* the minor from the major, and the Remainder, Exceſs or Difference I find to be 59; ſee the Work in the *Margent.*

125
66
59

Queſt. 2. A Gentleman oweth a *Merchant*, 365 *l.* whereof he hath paid 278 *l.* what more doth he owe?

To give an *Anſwer* to this *Queſtion*, I firſt ſet down the major *number* 365 *l.* and under it I place 278 the *minor*, and *ſubſtract* the one from the other, and thereby I diſcover the Exceſs, Difference or Remainder to be 87, and ſo much is ſtill due to the Creditor. As *per Margent.*

365
278
87

Queſt. 3. An obligation was written; a book printed, a Child born, a Church built, or any other thing made in the year of our Lord 1572, and now we account the year of our Lord 1687, the *Queſtion* is to know the age of the ſaid things, that is, how many years are paſſed ſince the ſaid things were made; I ſay if you *ſubſtract* the leſſer *number* 1572, from the greater 1687, the Remainder will be 115, and ſo many years are paſt ſince the making of the ſaid things; as by the Work in the Margent.

1687
1572
115

Queſt. 4. There are three Towns lie in a ſtreight line, *viz. London*, *Huntington*, and *York*; now the Diſtance between the furtheſt of theſe Towns, *viz. London* and *York* is 151 miles, and from *London* to *Huntington* is 49 miles, I demand how far it is from *Huntington* to *York*.

any

To resolve this *Question*, *substract* 49 the distance between *London* and *Huntington*, from 151 the Distance between *London* and *York*, and the Remainder is 102, for the true distance between *Huntington* and *York*. See the Work in the Margent.

	151
	49
	102

CHAP. VI.

Of Multiplication of whole Numbers.

1. *Multiplication* is performed by two *numbers* of like kind, for the *Production* of a third, which shall have such reason to the one, as the other hath to Unit, and in Effect is a most brief and artificial compound *Addition* of many equal *Numbers* of like kind into one Sum. Or *Multiplication* is that by which we *multiply* two or more *numbers*, the one into the other, to the end that their Product may come forth or be discovered.

Or, *Multiplication*, is the increasing of any one *number* by another; so often as there are Units in that *number*, by which the other is increased, or by having two *numbers* given to find a third, which shall contain one of the *Numbers* as many times as there are Units in the other.

2. *Multiplication* hath three parts, first the *Multiplicand*, or *number* to be *multiplyed*. Secondly, the *Multiplyer*, or *number* given, by which the *multiplicand* is to be *multiplyed*. And Thirdly, the *product* or *number*, produced by the other two, the one being multiplyed by the other, as if 8 were given to be multiplyed by 4, I say 4 times 8 is 32, here 8 is the *Multiplicand*, and 4 is the *Multiplyer*, and 32 is the Product.

	8
	4
	32

3. *Multiplication* is either single by one Figure, or compound that consists of many.

Single *Multiplication* is ſaid to conſiſt of one figure, becauſe the *Multiplicand* and *Multiplyer* conſiſt each of them of a Digit, and no more, ſo that the greateſt product that can ariſe by ſingle *Multiplication* is 81, being the ſquare of 9; and Compound *Multiplication* is ſaid to conſiſt of many figures, becauſe the *Multiplicand* or *Multiplyer* conſiſts of more places than one; as if I were to multiply 436 by 6, it is called Compound, becauſe the *Multiplicand* 436 is of more places than one, (*viz.*) 3 places.

4. The Learner ought to have all the varieties of ſingle *Multiplication* by heart before he can well proceed any further in this Art, it being of moſt Excellent Uſe, and none of the following Rules in *Arithmetick* but what have their principal dependance thereupon, which may be learnt by the following Table.

Multiplication Table.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The uſe of the precedent Table is this. In the uppermoſt Line or Column you have expreſſed all the digits from 1 to 9; and likewiſe beginning at 1 and going downwards in the ſide Column you have the ſame; ſo that if you would know the Product of any

any two ſingle numbers multiplyed by one another, look for one of them (which you pleaſe) in the uppermoſt Column, and for the other in the ſide Column, and running your eye from each Figure along the reſpective Columns, in the common Angle (or place) where theſe two Columns meet, there is the product required. As for Example, I would know how much is 8 times 7, firſt I look for 8 in the uppermoſt Column, and 7 in the ſide Column; then do I caſt my eye from 8 along the Column downwards from the ſame, and likewiſe from 7 in the ſide Column, I caſt my eye from thence towards the Right-hand, and find it to meet with the firſt Column at 56, ſo that I conclude 56 to be the Product required, it would have been the ſame if you had looked for 7 in the top, and 8 on the ſide, the like is to be underſtood of any other ſuch Numbers. The Learner being perfect herein, it will be neceſſary to proceed.

5. In Compound *Multiplication*, if the *Multiplicand* conſiſts of many places, and the *Multiplyer* of but one Figure; firſt ſet down the *Multiplicand*, and under it place the *Multiplyer* in the place of Units, and draw a Line underneath them; then begin and multiply the *Multiplyer* into every particular Figure of the *Multiplicand*, beginning at the place of Units, and ſo proceed towards the left hand, ſetting each particular Product under the Line, in order as you proceed, but if any of the Products exceed 10 or any number of Tens, ſet down the Exceſs, and for every 10 carry a Unit to be added to the next product, always remembring to ſet down the Total Product of the laſt Figure; which work being finiſhed, the Sum or Number placed under the Line ſhall be the true and Total Product required. As for Example, I would multiply 478 by 6, firſt I ſet down 478, and underneath it 6 in the place of Units, and draw a line underneath them as in the Margent, then I begin, ſaying 6 times 8 is 48, which is 8 above 4 Tens, therefore I ſet down 8 (the exceſs) and

478
6
2868

ing 6 times 7 is 42, and 4 that I carried is 46, I then ſet down 6 and carry 4, and go on, ſaying 6 times 4 is 24, and 4 that I carried is 28, and becauſe it is the laſt Figure, I ſet it all down, and ſo the work is finiſhed, and the product is found to be 2868, as was required.

6. When in Compound *Multiplication* the Multiplier conſiſteth of divers places, then begin with the Figure in the place of Units in the Multiplyer, and multiply it into all the Figures in the Multiplicand, placing the product below the line as was directed in the laſt Example; then begin with the Figure of the ſecond place of the Multiplyer, (*viz.*) the place of Tens, and multiply it likewiſe into the whole Multiplicand (as you did the firſt Figure) placing its product under the product of the firſt Figure, do in the ſame manner by the third, fourth and fifth, *&c.* until you have multiplyed all the Figures of the Multiplyer particularly into the whole Multiplicand, ſtill placing the Product of each particular Figure under the Product of its precedent Figure; herein obſerving the following Caution.

A Caution In the placing of the Product of each particular Figure of the Multiplier, you are not to follow the 2*d.* Rule of the 4*th.* Chapter, *viz.* not to place Units under Units, and Tens under Tens, *&c.* but to put the Figure or Cypher in the place of Units of the ſecond line under the ſecond figure or place of Tens in the line above it, and the Figure or Cypher in the place of Units of the third line under the place of Tens in the ſecond line, *&c.* Obſerving this order till you have finiſhed the work, *viz.* ſtill placing the firſt figure of every line or product under the ſecond Figure or place of Tens in that which was above it, and having ſo done, draw a line under all theſe particular products, and add them together; ſo ſhall the ſum of all theſe Products be the Total Product required.

As if it were required to multiply 764 by 27, I ſet them down the one under the other with a line drawn

underneath them; then I begin, saying 7 times 4 is 28, then I set down 8, and carry 2, then say 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4; then 7 times 7 is 49, and 4 that I carry is 53, which I set down because I have not another Figure to multiply; thus have I done with the 7, then I begin with the 2, saying 2 times 4 is 8, which I set down under (4) the second Figure o place of Tens in the Line above it, as you may se in the Margent: Then I proceed, saying 2 times is 12, that is 2 and carry one, then 2 times 7 is 14 and 1 that I carry is 15, which I set down becau 'tis the product of the last Figure; so that the produc of 764 by 7 is 5348, and by 2 is 1528, which being placed the one under the other as before is directed and as you see in the Margent, and a Line drawn under them, and they added together respectively, make 20628 the true Product required, being equal to 27 times 764.

	76
	2
	534
	1528
	2062

Another Example may be this; Let it be required to multiply 5486 by 465, I dispose of the Multiplicand and Multiplyer, according to Rule, and begin multiplying the first Figure of the Multiplyer, which is five into the whole Multiplicand, and the Product is 27430; then I proceed and multiply the second Figure (6) of the Multiplier into the Multiplicand, and find the product to amount to 32916 which is subscribed under the other product respectively, then do I multiply the third and last figure (4) of the Multiplyer into the Multiplicand, and the Product is 21944, which is likewise placed under the second Line respectively; then I draw a Line under the said Products (being placed the one under the other according to Rule) and add them together, and the sum is 2550990 the true Product sought, being equal to 5486 times 465, or 465 times 5486.

	5486
	465
	27430
	32916
	21944
	2550990

More Examples in this Rule are these following.

430865	6400758
4739	37496
3877785	38404548
1292595	57606822
3016055	25603032
1723460	44805306
	19202274
2041869235	240002821968

Compendiums in Multiplication.

7. Although the former Rules are sufficient for all Cases in Multiplication, yet becauſe in the Work of Multiplication many times great labour may be ſaved, I ſhall acquaint the Learner with ſome Compendiums in order thereto, *viz.* If the Multiplicand or Multiplyer, or both of them end with Cyphers, then in your multiplying you may neglect the Cyphers, and multiply only the ſignificant Figures, and to the Product of thoſe ſignificant Figures, add ſo many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the Right hand of the ſaid product, ſo ſhall that give you the true product required. As if I were to multiply 32000 by 4300, I ſet them down in order to be multiplyed as you ſee in the Margent, but neglecting the Cyphers in both numbers I only multiply 32 by 43, and the Product I find to be 1376, to which I annex the 5 Cyphers that are in the Multiplicand and Multiplyer, and then it makes 137600000 for the true Product of 32000 by 4300.

Si e numeris propoſitis unus vel uterque adjunctos habeat a i dextram circulos; omiſſis circulis fiat ipſorum numerorum multiplicatio & facto demum tot inſuper interprorum loci accenſeantur quot ſunt omiſſi circuli in utroque factore, Clavis Ma. c. 4. 3.

32000	
4300	
96	
128	
137600000	

8. If

8. If in the Multiplyer Cyphers are placed between ſignificant figures, then multiply only by the ſignificant Figures neglecting the Cyphers, but here ſpecial notice is to be taken of the true placing of the firſt figure after the neglect of ſuch Cypher or Cyphers; and therefore you muſt obſerve in what place of the multiplyer the Figure you multiply by ſtandeth, and ſet the firſt Figure of that Product under the ſame place of the product of the firſt figure of your Multiplyer. As for Example, let it be required to multiply 371568 by 40007, firſt I multiply the Multiplicand by 7, and the Product is 2600976, then neglecting the Cyphers I multiply by 4, and that Product is 1486272, now I conſider that 4 is the fifth figure in the Multiplier, therefore I place two (the firſt Figure of the product by four) under the fifth place of the firſt Product by 7, and the reſt in order, and having added them together, the Total Product is found to be 14865320976, other Examples in this Rule are theſe following.

Si intermedio multiplicantis loco circulus fuerit, ille negligitur. Alfted. Cap. 6. de Arithm.

```
  371568
   40007
 -------
 2600976
1486272
-------
14865320976
```

```
  327586
    6030
 -------
  982758
 1965516
 -------
 1975343580
```

```
  7864371
    20604
 -------
 31457484
 47186226
 15728742
 -------
 162037500084
```

9. If you are to multiply any Number by an Unit with Cyphers, (*viz.*) by 10, 100, 1000, *&c.* then annex ſo many Cyphers before the Multiplicand, and that *number* when the Cyphers are annexed is the Product required; as if you would multiply 428 by 100, annex two Cyphers to 428 and it is 42809: If it were

required to multiply 102 by 10000, annex 4 Cyphers and it gives 1020000 for the Product required.

The Proof of Multiplication.

10. Multiplication is proved by Division, and to speak truth all other ways are false; and therefore it will be most convenient in the first place, to learn Division, and by that to prove Multiplication. There is a Way (at this day generally used in Schools) to prove Multiplication, which is this, first add all the Figures in the Multiplicand together, as if they were simple Numbers, casting away the Nines as often as it comes to so much, and noting the Remainder at last, which in this case cannot be so much as 9: Cast likewise the Nines out of the Multiplier as you did out of the Multiplicand, and note that Remainder; then multiply the Remainders, the one by the other, and cast the Nines out of that Product, observing the Remainder; and lastly, cast the Nines out of the Total Product, and if this Remainder be equal to the Remainder last found, then they conclude the Work to be rightly performed; but there may be given a thousand (nay infinite) false Products in a Multiplication, which after this manner may be proved to be true, and therefore this way of proving doth not deserve any Example; but we shall defer the Proof of this Rule till we come to prove Division, and then we shall prove them both together.

Non est quod aliam expectes examinandi viam; nam aliæ vulgares & falsæ sunt, & nullo innixæ fundamento:

11. The general effect of Multiplication is contained in the definition of the same, which is to find out a 3*d*. Number, so often containing one of the two given Numbers as the other containeth Unit.

The second effect is by having the length and breadth of any thing (as a Parallelogram, or long Plain) to find the superficial Content of the same, and by having the superficial Content of the Base and the length to find out the solidity of any Parallelopipedon, Cylinder or other solid Figures. The

The third Effect is by the contents, price, valu buying, ſelling, expence, wages, exchange, ſimp intereſt, gain or loſs of any one thing, be it Mone Merchandize, *&c.* to find out the value, price, ex pence, buying, ſelling, exchange, or intereſt of an Number of things of like Name, Nature and Kind.

The fourth effect is (not much unlike the other by the Contents, Value, or Price of one part of any thing denominated, to find out the Content, Valu or Price of the whole thing, all the parts into which the whole is divided, multiplying the price of one o thoſe parts.

The fifth effect is, to aid, to compound, and to make other Rules, as chiefly the Rule of Proportion, called the Golden Rule, or Rule of Three; alſo by it, things of one Denomination are reduced to another.

If you multiply any number of Integers or the price of the Integer, the Product will diſcover the price of the Quantity or Number of Integers given.

In a Rectangular Solid, if you multiply the breadth of the Baſe by the depth, and that Product by the length, this laſt Product will diſcover the Solidity or Content of the ſame Solid.

Some Queſtions proper to this Rule may be theſe following.

Queſt. 1. What is the Content of a ſquare piece of Ground, whoſe length is 28 *perches*, and breadth 13 *perches?*

Anſw. 364 ſquare *perches*, for multiplying 28 the length by 13 the breadth, the Product is ſo much.

Queſt. 2. There is a ſquare battle whoſe Flank is 47 Men, and the Files 19 deep, what number of Men doth that Battle contain? *Facit* 893; for multiplying 47 by 19, the Product is 893.

Queſt. 3. If any one thing coſt 4 ſhillings, what ſhall 9 ſuch things coſt? *Anſwer* 36 ſhillings; for multiplying 4 by 9, the Product is 36.

Queſt. 4. If a piece of Money or Merchandize be worth or coſt 17 ſhillings, what ſhall 10 ſuch pieces

of Money or Merchandize cost? *Facit* 323 shillings, which is equal to 16 *l.* 03 *s.*

Quest. 5. If a Soldier or Servant get or spend 14 *s.* per Month, what is the Wages or Charges of 49 Soldiers or Servants for the same time? Multiply 49 by 14, the Product is 686 *s.* or 34 *l.* 06 *s.* for the *Answer.*

Quest. 6. If in a day there are 24 hours, how many hours are there in a year, accounting 365 days to constitute the year? *Facit* 8760 hours, to which if you add the 6 hours over and above 365 days as there is in a year, then it will be 8766 hours, now if you multiply this 8766, by 60, the number of Minutes in an Hour, it will produce 525960 for the number of Minutes in a Year.

CHAP. VII.

Of Division of Whole Numbers.

1. DIVISION is the separating or parting of any Number or Quantity given into any parts assigned; or to find how often one Number is contained in another: Or from any two Numbers given to find a third that shall consist of so many Units, as the one of those two given Numbers is comprehended or contained in the other.

2. Division hath three Parts or Numbers remarkable, *viz.* First, the Dividend. Secondly, the Divisor. Thirdly, the Quotient. The Dividend is the Number given to be parted or divided. The Divisor is the Number given, by which the Dividend is divided: Or it is the Number which sheweth how many parts the Dividend is to be divided into, And the Quotient is the number produced by the Division of the two given Numbers, the one by the other.

So 12 being given to be divided by 3, or into three equal parts, the Quotient will be 4, for 3 is contained in 12 four times, where 12 is the Dividend, and 3 is the

3. In Division set down your Dividend, and draw a crooked line at each end of it, and before the line at the left hand, place the Divisor, and behind that on the right hand, place the Figures of the Quotient, as in the Margent, where it is required to divide 12 by 3: First I set down 12 the Dividend, and on each side of it do I draw a crooked line, and before that on the left hand do I place 3 the Divisor; then do I seek how often 3 is contained in 12, and because I find it 4 times, I put 4 behind the crooked line on the right hand of the Dividend, denoting the Quotient.

3) 12 (4

4. But if when the Divisor is a single Figure, the Dividend consisteth of two or more places, then (having placed them for the Work as is before directed) put a point under the first Figure on the left hand of the Dividend, provided it be bigger than (or equal to) the Divisor, but if it be lesser than the Divisor, then put a point under the second Figure from the left hand of the Dividend, which Figures as far as the point goeth from the left hand are to be reckoned by themselves, as if they had no dependance upon the other part of the Dividend, and for distinction sake may be called the Dividual, then ask how often the Divisor is contained in the Dividual, placing the Answer in the Quotient; then multiply the Divisor by the Figure that you placed in the Quotient, and set the Product thereof under the Dividual; then draw a line under that Product, and substract the said Product from the Dividual, placing the remainder under the said line, then put a point under the next Figure in the Dividend, on the right hand of that which you put the point before, and draw it down, placing it on the right hand of the Remainder, which you found by Substraction; which remainder with the said figure annexed before it, shall be a new Dividual; then seek again how often the Divisor is contained in this new Dividual; and put the Answer in the Quotient on the right hand of the Figure which you put there before, then multiply the Divisor by the last Figure that you

put in the Quotient and ſubſcribe the Product under the Dividual, and make Subſtraction, and to the Remainder draw down the next Figure from the grand Dividend, (having firſt put a point under it) and put it on the right hand of the Remainder for a new dividual as before, *&c.* and proceed thus till the Work is finiſhed.

Obſerving this general Rule in all kinds of Diviſion, firſt to ſeek how often the diviſor is contained in the dividual; then (having put the anſwer in the Quotient) multiply the diviſor thereby, and ſubſtract the Product from the dividual. An Example or two will make the Rule plain. Let it be required to divide 2184 by 6. I diſpoſe of the Numbers given as is before directed, and as you ſee in the Margent, in order to the Work; then (becauſe 6 the diviſor is more than 2 the firſt Figure of the dividend) I put a point under 1 the ſecond Figure, which makes 21 for the dividual, then do I ask how often 6 the diviſor is contained in 21, and becauſe I cannot have it more than 3 times, I put 3 in the Quotient, and thereby do I multiply the diviſor (6) and the product is 18, which I ſet in order under the dividual, and ſubſtract it therefrom, and the remainder (3) I place in order under the line, as you ſee in the Margent.

```
6)2184(
  .
6)2184(3
  .
  18
  --
   3
```

Then do I make a point under the next Figure of the dividend being 8, and draw it down, placing it before the Remainder 3, ſo have I 38 for a new dividual, then do I ſeek how often 6 is contained in 38, and becauſe I cannot have more than 6 times, I put 6 in the Quotient, and thereby do I multiply the diviſor 6, and the product (36) I put under the dividual (38) and ſubſtract it therefrom, and the remainder 2 I put under the Line, as you ſee in the Margent.

```
6)2184(36
  ..
  18
  --
  38
  36
  --
   2
```

Then do I put a point under the next (and last) Figure of the dividend (being 4) and draw it down to the remainder 2, and putting it on the Right hand thereof, it maketh 24 for a new dividual; then I seek how often 6 is contained in 24, and the Answer is 4, which I put in the quotient and multiply the Divisor (6) thereby; and the product (24) I put under the dividual (24) and substract it therefrom, and the Remainder is 0, and thus the Work is finished, and I find the Quotient to be 364, that is, 6 is contained in 2184 just 364 times, or 2184 being divided into 6 equal parts, 364 is one of those parts.

```
6)2184)364
...
 18
 ---
  38
  36
  --
   24
   24
   --
   00
```

Again, If it were required to divide 2646 by 7 or into 7 equal parts, the Quotient would be found to be 378, as by the following Operation appeareth.

```
7) 2646 (378
...
 21
 --
  54
  49
  --
   56
   56
   --
   00
```

So if it were required to divide 946 by 8, the Quotient will be found to be 118, and 2 remaining after Division is ended. The Work followeth.

```
8) 946 (118
   ...
   8
  ---
  14
   8
  ---
  66
  64
  ---
   (2)
```

Many times the dividend cannot exactly be divided by the divisor, but something will remain, as in the last Example, where 946 was given to be divided by 8, the quotient was 118 and there remaineth 2 after the Division is ended: Now what is to be done in this case with the Remainder, the Learner shall be taught when we come to treat of the reducing (or Reduction) of Fractions.

And here note that if after your Division is ended, any thing do remain, it must be lesser than your divisor, for otherwise your Work is not rightly performed.

Other Examples are such as follow.

```
8) 73464 (9183
   ....
   72
  ---
   14
    8
  ---
   66
   64
  ---
    24
    24
  ---
    (0)
```

```
9) 13758 (1528
   ....
   9
  ---
   47
   45
  ---
    25
    18
  ---
    78
    72
  ---
    (6)
```

5. But if the Divisor consisteth of more places than one, then chuse so many Figures from the left side of the dividend for a dividual as there are figures in the divisor, and put a point under the farthest Figure of that Dividual to the Right hand, and seek how often the first Figure on the left side of the Divisor, is contained in the first Figure on the left side of the dividual, and place the Answer in the Quotient, and thereby multiply your Divisor, placing your product under your dividual, and substract it therefrom, placing the Remainder below the line; then put a point under the next Figure in the Dividend, and draw it down to the said Remainder, and annex it on the right side thereof, which makes a new dividual, and proceed as before, till the work is finished.

And if it so happen that after you have chosen your first dividual (as is before directed) you find it to be lesser than the divisor, then put a point under a figure more near to the right hand, and seek how often the first Figure on the left side of the divisor is contained in the two first Figures on the left side of the dividual, and place the answer in the quotient, by which multiply the divisor, and place the product thereof in order under the dividual, and substract it therefrom, and proceed as before.

Always remembring, that (in all the cases of Division) if after you have multiplyed your Divisor by the Figure last placed in the Quotient, the product be greater than the dividual, then you must cancel that Figure in the Quotient, and instead thereof put a Figure lesser by a Unit (or one) and multiply the Divisor thereby, and if still the product be greater than the dividual, make the Figure in the quotient yet lesser by a Unit, and thus do until your product be lesser than the dividual, or at the most equal thereto, and then make Substraction, *&c.*

So if you would divide 9464 by 24, the quotient will be found to be 394, I first put down the given Numbers, as before is directed in the third Rule: Now

because my Divisor consisteth of two Figures, I therefore put a point under the second Figure from the left hand in my Dividend, which here is 4, wherefore I seek how often 2 the first Figure (on the left side of the Divisor) is contained in 9 (the like first in the Dividual) the answer is 4, which I put in the quotient, and thereby multiply all the divisor and find the product to be 96, which is greater than the dividual 94, wherefore I cancel the 4 in the quotient, and instead thereof I put 3 (a Unit lesser) and by it multiply the divisor 24, and the product is 72, which I substract from 94 the Dividual, and the Remainder is 22, then do I make a point under the next figure 6 in the Dividend, and draw it down and place it on the right side of the Remainder 22, and it makes 226 for a new dividual, now because the dividual 226 consisteth of a Figure more than the Divisor, therefore I seek how often 2 (the first Figure of the Divisor is contained in 22 the two first of the dividual) I say nine times, wherefore I put 9 in the quotient, and thereby multiply the Divisor 24, the product (216) I place under the dividual 226, and substract it from it, and there remaineth 10.

```
24)9464(3
   ..  4
   72
   ---
   22
```

```
24)9464(39
   ..
   72
   ---
   226
   216
   ---
   10
```

Then I go on and make a point under the next and last Figure (4) in the Dividend, and draw it down to the Remainder 10, and it maketh 104, for a new dividual, which is also a Figure more than the Divisor, and therefore I seek how often two is contained in ten, I answer five times, but multiplying my Divisor by 5, the product is 120, which is greater than the Divisor, and therefore I make it but 4, and by it multiply the divisor, and the product is 96, which being placed under, and substracted from the dividual there remaineth 8, and thus the whole work of this Division is ended, and I find that 9464 being divided by 24,

or in 24 equal parts, is found to be 394, as was said before, and the Remainder is 8, as you see in the Work following.

```
24) 9464 (394
    ....
    72
    ---
     226
     216
     ---
     104
      96
     ---
      (8)
```

Another Example may be this, let there be required the quotient of 1183653 divided by 385, first I dispose of the *numbers* in order to their dividing, and because 118 the three first Figures of the dividend is lesser than the divisor 385, I therefore make a point under the fourth Figure, which is 3, and seek how often 3 (the first Figure of the divisor) is contained in 11? The Answer is 3, which I put in the Quotient, and thereby multiply the Divisor 385, and the Product is 1155 which I substract from the Dividual 1188, and there remains 28. Then (as before) I draw down the next Figure, which is 6, and place it before the Remainder 28, so have I 286 for a new dividual, and because it hath no more Figures than the Divisor, I seek how often 3 (the first Figure in the divisor) is contained in 2 (the first Figure of the dividual, and the Answer is 0, for a greater number cannot be contained in a lesser, wherefore I put 0 in the quotient, and thereby (according to the 5*th* Rule) I should multiply my Divisor, but if I do the product will be 0,

```
385)1183653(3
    .
    1155
    ----
      28
```

```
385) 1183653 (30
     ..
     1155
     ----
      286.
```

and 0 subſtracted from the dividual 286, the remainder is the ſame; wherefore I draw down the next Figure (5) from the dividend, and put it before the ſaid Remainder 286, ſo have I 2865 for a new dividual, and becauſe it conſiſteth of four places, (*viz.*) a place more than the diviſor, I ſeek how often 3 (the firſt Figure of the diviſor) is contained in 28 (the two firſt of the dividual) and I ſay there is 9 times 3 in 28, but multiplying my whole diviſor (385) thereby I find the product to be 3465, which is greater than the dividual 2865, wherefore I chooſe eight which is leſſer by a Unit than nine, and thereby I multiply my diviſor 385, and the product is 3080, which ſtill is greater than the ſaid dividual, wherefore I chooſe another number yet a Unit leſſer, *viz.* 7; and having multiplyed my diviſor thereby, the Product is 2695, which is leſſer than the dividual 2865, wherefore I put 7 in the Quotient, and ſubſtract 2695 from the dividual 2865, and there remains 170, then I draw down the laſt figure (3) in the dividend, and place it before the ſaid Remainder 170, and it makes 1703 for a new dividual, then (for the Reaſon aboveſaid) I ſeek how often 3 is contained in 17, the anſwer is 5, but multiplying the Diviſor thereby, the Product is (1925) greater than the dividual, wherefore I ſay it will bear 4 (a Unit leſſer) and by it I multiply the Diviſor 385 and the Product is 1540, which is leſſer than the dividual, and therefore I put 4 in the Quotient, and ſubſtract the ſaid Product from the dividual, and there remaineth 163, and thus the Work is finiſhed, and I find that 1183653 being divided by 385,

```
385)1183653(307
    ...
    1155
    ----
    2865
    2695
    ----
     170
```

```
385)1183653(3074
    ....
    1155
    ----
    2865
    2695
    ----
    1703
    1540
    ----
     163
```

or into 385 equal shares or parts, the Quotient (or one of those parts) is 3074, and besides there is 163 remaining.

And thus the Learner being well versed in the Method of the foregoing Examples, he may be sufficiently qualified for the dividing of any greater Sum or Number into as many parts as he pleaseth, that is, he may understand the method of dividing by a Divisor, which consisteth of 4 or 5, or 6, or any greater number of places, the method being the same with the foregoing Examples in every respect.

Other Examples of Division.

27986) 835684790 (2986•
.....
55972
275964
251874
240907
223888
170199
167916
Remains (22830)

196374) 473986018 (2413
....
392748
812380
785496
268841
196374
724678
589122
Remains (135556)

So if you divide 47386473 by 58736, you will find the Quotient to be 806, and 45257 will remain after the work is ended.

In like manner if you would divide 3846739204 by 483064, the Quotient will be 7963, and the Remainder after Division will be 100572.

Compendiums in Division.

1. IF any given Number be to be divided by another number that hath Cyphers annexed on the right side thereof, (omitting the Cyphers) you may cut off so many Figures from the right hand of the Dividend, as there are Cyphers before the Divisor and let the Remaining Numbers in the Dividend, be divided by the remaining number or numbers in the Divisor, observing this Caution, that if after your Division is ended any thing remain, you are to annex thereto, the *number* or *numbers* that were cut off from the *dividend*; and such new found *number* shall be the Remainder. As for Example: Let it be required to divide 46658 by 400; now because there are two Cyphers before the Divisor, I cut off as many Figures from before the *Dividend*, *viz.* 58. so that then there will remain only 466 to be divided by 4, and the Quotient will be 116, and there will remain 2, to which I annex the two Figures (58) which were cut off from the *dividend*, and it makes 258 for the true Remainder, so that I conclude 46658 being divided by 400, the Quotient will be 116, and 258 remaineth after the Work is ended; as by the Work in the Margent.

Et si Divisor adjunctos sibi habeat Circulos ad dextram, omissis circulis & abscissis totidem ultimis Figuris dividendi, in numeris reliquis fiat divisio, in fine autem divisionis restituendi sunt tum omissi circuli; tum figuræ abscissæ. Ought. Cla. Matth. cap. 5, 3.

```
4|00)466|58(116
     ..
     4
     ---
     6
     4
     ---
     26
     24
     ---
     258
```

2. And hence it followeth that if the Diviſor be (1) or a Unit with Cyphers annexed, you may cut off ſo many figures from before the dividend, as there are Cyphers in the Diviſor, and then the figure or figures that are on the Left-hand, will be the Quotient, and thoſe that are on the Right-hand will be the Remainder, after the Diviſion is ended :. As thus, if 45483 were to be divided by 10, I cut off the laſt Figure (3) with a daſh thus (4578|3) and the work is done, and the quotient is 4578 (the number on the left hand of the daſh) and the Remainder is 3 (on the Right hand ;) in like manner if the ſame number 45783 were to be divided by 100, I cut off 2 Figures from the end thus (457|83) and the Quotient is 457, and the remainder is 83. And if I were to divide the ſame by 1000, I cut off 3 Figures from the end thus (45|783) and the Quotient is 45, and 783 the Remainder, *&c.*

Diviſurus quemcunque numerum per 10. Auferex dextra parte unicam; eamque primam figuram: Reliqua enim figuræ productum oſtendunt, Ablatum Reſiduum, &c. Gem. Frſ. Aſtrh. part. 1.

6. The General Effect of Diviſion is contained in the definition of the ſame (that is) by having two unequal numbers given to find a third number in ſuch proportion to the dividend, as the diviſor hath to Unit or 1, it alſo diſcovers what reaſon or proportion there is between numbers, ſo if you divide 12 by 4, it quotes 3, which ſhews the reaſon or proportion of 4 to 12 is triple.

The ſecond Effect is by the ſuperficial meaſure or content, and the length of any Oblong, Rectangular Parallelogram, or ſquare Plain known, to find out the breadth thereby, or contrariwiſe by having the ſuperficies, and breadth of the ſaid Figure, to find out the length thereof. Alſo by having the ſolidity and length of a Solid, to find the Superficies of the Baſe, *& e contra.*

The third effect is, by the contents, reaſon, price, value, buying, ſelling, expences, wages, exchange, intereſt, profit or loſs of any number of things (be it Money, Merchandize, or what elſe (to find out the

contents, reaſon, price, value, buying, ſelling, expence, wages, exchange, intereſt, profit or loſs, of any one thing of like kind.

The fourth effect is to aid, to compoſe, and to make other Rules, but principally the Rule of Proportion, called the Golden Rule, or Rule of Three, and the Reduction of Moneys, Weights, and Meaſures, of one denomination into another, by it alſo Fractions are abbreviated by finding a common meaſurer, unto the Numerator and Denominator, thereby diſcovering commenſurable numbers.

If you divide the Value of any certain quantity, by the ſame quantity, the quotient diſcovers the rate or value of the Integer, as if eight yards of Cloth coſt 29 ſhillings; if you divide (96) the value or price of the given quantity, by (8) the ſame quantity, the quotient will be 128, which is the value or price of 1 of thoſe yards, *& e contra.*

If you divide the Value or Price of any unknown quantity, by the value of the Integer, it gives you in the Quotient that unknown quantity whoſe price is thus divided; as if 12 ſhillings were the value of 1 yard, I would know how many yards are worth 96 ſhillings: Here if you divide (96) the price or value of the unknown quantity, by (12) the rate of the Integer, or one yard, the quotient will be 8, which is the number of yards worth 96 ſhillings.

Some Queſtions anſwered by Diviſion may be theſe following.

Queſt. 1. If 22 things coſt 66 ſhillings, what will 1 ſuch thing coſt; *facit* 3 ſhillings, for if you divide 66 by 22, the Quotient is 3 for the Anſwer; ſo if 36 yards or ells of any thing be bought or ſold for 108 *l.* how much ſhall 1 yard or ell be bought or ſold for? *facit* 3 *l.* for if you divide 108 *l.* by 36 yards, the Quotient will be 3 *l.* the price of the Integer.

Queſt. 2. If the Expence, Charges or Wages of 7 years amount to 868 *l.* what is the Expence, Charges,

868 (the Wages of 7 years) by 7 (the Number of years) the Quotient will be 124 *l.* for the Answer see the Work.

```
7) 868 (124
   ...
    7
   ---
    16
    14
   ---
     28
     28
   ---
     (0)
```

Queſt. 3. If the content of our Superficial Foot be 144 Inches, and the breadth of a board be 9 inches, how many inches of that board in length will make ſuch a foot ? *facit* 16 inches; for by dividing 144 (the number of ſquare Inches in a ſquare Foot,) by 9 (the Inches in the breadth of the board) the Quotient is 16 for the number of Inches in length of that board to make a ſuperficial Foot.

```
9) 144 (16 Inches
   ...
    9
   ---
    54
    54
   ---
    (0)
```

Queſt. 4. If the content of an Acre of Ground be 160 ſquare Perches, and the length of a Furlong (propounded) be 80 Perches, how many Perches will there go in breadth to make an Acre, *facit* 2 Perches; for if you divide 160 (the number of Perches in an Acre) by 80 (the length of the Furlong in Perches) the Quotient is 2 Perches; and ſo many in breadth of that Furlong will make an Acre.

80) 160 (2 *Perches.*

160

(0)

Queſt. 5. If there be 893 Men to be made up into a battle, the Front conſiſts of 47 Men, what *number* muſt there be in the File? *Facit* 19 deep in the File: For if you divide 893 (the *number* of men) by 47 (the *number* in Front) the Quotient will be 19 File in depth; the Work followeth;

47) 893 (19 *deep in file*

47

423
423

(0)

Queſt. 6. There is a *Table* whoſe Superficial content is 72 feet, and the breadth of it at the end is 3 feet, now I demand what is the length of this Table? *Facit* 24 feet long; for if you divide 72 (the content of the Table in feet) by 3 (the breadth of it) the Quotient is 24 feet for the length thereof, which was required. See the Operation as followeth;

3) 72 (24

6

12
12

(0)

The Proof of Multiplication and Diviſion.

Multiplication and *Diviſion* interchangeably prove each other; for if you would prove a Sum in *Diviſion*, whether the Operation be right or no, Multiply

the *Quotient* by the *Divisor*; and if any thing remain after the *Division* was ended, add it to the Product, which Product (if your Sum was rightly *divided*) will be equal to the *Dividend*: And contrariwise, if you would prove a Sum in *Multiplication*, *divide* the *Product* by the *Multiplyer*, and if the work was rightly performed, the *Quotient* will be equal to the Multiplicand. See the Example where the Work is done and undone: Let 7654 be given to be multiplyed by 3242, the Product will be 24814268 as by the Work appeareth.

```
  7654
  3242
 -----
 15308
 30616
 15308
 22962
 -----
24814268
```

And then if you *divide* the said *Product* 24814268 by 3242 the *Multiplier*, the *Quotient* will be 7654 equal to the given Multiplicand.

```
3242)24814268(7654
      ....
  22694
 -----
  21202
  19452
 -----
  17506
  16210
 -----
  12968
  12968
 -----
```

In like manner (to prove a Sum or Number in *Division*) If 24814268 were *divided* by 3242 the Quotient would be found to be 7654; then for proof, if you multiply 7654 the Quotient by 3242 the *Divisor*, the Product will amount to 24814268, equal to the *Dividend*.

Or you may prove the last or any other Example in *Multiplication* thus, *viz. Divide* the Product by the Multiplicand, and the Quotient will be equal to the Multiplyer. See the Work.

```
          7654
          3242
        -------
         15308
        30616
       15308
      22962
    ----------
7654)24814268(3242
        ....
      22962
      -----
       18522
       15308
       -----
        32146
        30616
        -----
         15308
         15308
         -----
          (0)
```

From whence there ariseth this Corollary, that any Operation in *Division* may be proved by *Division*; for if after your *Division* is ended, you divide the *dividend* by the Quotient, the new Quotient thence arising will be equal to the *Divisor* of the first operation; for tryal whereof let the last Example be again repeated.

3242) 24814268 (7654
....
22694
21202
19452
17506
16210
12968
12968
(o)

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the first *Divisor* 3242; see the Work.

7654) 24814268 (3242
....
22962
18522
15308
32146
30616
15308
15308
(o)

But in proving *Division* by *Division*, the Learner is to observe this following Caution, that if after his *Division* is ended there be any Remainder, before you go about to prove your Work, substract that Remainder out of your Dividend, and then work as before, as in the following Example, where it is required to divide 43876 by 765, the Quotient here is .57, and the remainder is 271; see the Work following.

765) 43876 (57
3825
5626
5355
(271)

Now to prove this Work ſubſtract the Remainder 271 out of the *Dividend* 43876 and there remaineth 43605 for a new *dividend* to be divided by the former Quotient 57, and the Quotient thence ariſing is 765 equal to the given *Diviſor*, which proveth the Operation to be right.

43876
271
57) 43605 (765
399
370
342
285
285
(0)

Thus have we gone through the four Species of Arithmetick, *viz.* Addition, Subſtraction, Multiplication, and Diviſion; upon which all the following Rules and all other Operations whatſoever that are poſſible to be wrought by Numbers have their immediate dependance, and by them are reſolved. Therefore before the Learner make a further ſtep in this Art, let him be well acquainted with what hath been delivered in the foregoing Chapters.

Hæ ſunt igitur quatuor illæ ſpecies Arithmeticæ per quas omnia quæcunque deinceps dicenda ſunt vel quæ per numeros fieri poſſibile eſt, abſolvuntur: Quare eas quiſquis es ante omnia perdiſces. Sem. Friſ. Arith. par. 1

CHAP. VIII.

Of Reduction.

1. *Reduction* is that which brings together 2 or more numbers of different denominations into one denomination; or it serveth to change or alter Numbers, Money, Weight, Measure or Time, from one denomination to another; and likewise to abridge Fractions to their lowest *Terms*. All which it doth so precisely, that the first *Proportion* remaineth without the least jot of *Error* or *Wrong* committed. So that it belongeth as well to *Fractions* as *Integers*, of which in its proper place. *Reduction* is generally performed, either by Multiplication or Division; from whence we may gather, that,

Hills Arith. Ch. 13. 152.

2. *Reduction* is either Descending or Ascending.

3. *Reduction* Descending, is when it is required to *reduce* a *Sum* or *Number* of a greater Denomination, into a lesser; which *Number*, when it is so reduced, shall be equal in value to the *number* first given in the greater Denomination; as if it were required to know how many *shillings, pence*, or *farthings* are equal in value to an *hundred pounds?* or how many *ounces* are contained in 45 *hundred weight*; or how many *days, hours*, or *minutes*, there are in 240 *Years, &c.* And this kind of *Reduction* is generally performed by Multiplication.

Wing. Arith. ch. 7. 2,3,4.

4. *Reduction* Ascending, is when it is Required to *Reduce* or *Bring* a *Sum* or *Number* of a smaller Denomination into a greater, which shall be equivalent to the given *number*; as suppose it were required to find out how many Pence, Shillings or Pounds are equal in value to 43785 *Farthings*; or how many *Hundreds* are equal to (or in) 3748 *pounds, &c.* and this kind of *Reduction* is always performed by *Division*.

5. When any *Sum* or *Number* is given to be *reduced* into another Denomination, you are to consider whe-

ther it ought to be resolved by the Rule descending or ascending, *viz.* by Multiplication or Division: If it be to be performed by Multiplication, consider how many parts of the Denomination into which you would reduce it, are contained in a *Unit* or *Integer* of the given *Number*, and multiply the said given *number* thereby, and the Product thereof will be the Answer to the Question. As if, the Question were, in 38 *pounds*, how many *shillings?* Here I consider, that in one *pound* are 20 *shillings*, and that the number of *shillings* in 38 *pounds* will be 20 times 38, wherefore I multiply 38 *l.* by 20, and that product is 760, and so many *shillings* are contained in 38 *pounds*, as in the Margent.

38	
20	
760	

But when there is a Denomination, or Denominations between the *Number* given, and the *Number* required, you may (if you please) reduce it into the next inferiour Denomination, and then into the next lower than that, *&c.* until you have brought it into the Denomination required: As for Example, let it be demanded in 132 *pounds* how many *farthings?* First, I multiply 132 (the *Number* of *pounds* given by 20 to bring it into *shillings*) and it makes 2640 *shillings*, then do I multiply the *shillings* (2640) by 12, to bring them into *pence*, and it produceth 31680, and so many *pence* are contained in 2640 *shillings*, or 132 *pounds*; then do I multiply the *pence*, *viz.* 31680 by 4 to bring them into *farthings* (because 4 *farthings* is a *penny*) and I find the *product* thereof to be 126720, and so many *farthings* are in equal value to 132 *pounds*, the Work is manifest in the Margent.

132 *pounds*	
20	
2640 *shill.*	
12	
5280	
2640	
31680 *pence*	
4	
126720 *farth.*	

6. And if the *number* propounded to be reduced, is to be divided, or wrought by the Rule Ascending,

consider how many of the given *numbers* are equal to an *Unit* or *Integer*, in that denomination to which you would *reduce* your given *number*, and make that your *Divisor*: and the given *number* your *Dividend*; and the *Quotient* thence *arising* will be the *number* sought or required: As for Example, Let it be required to reduce 2640 *shillings* into *pounds*, here I consider that 20 *shillings* are equal to one pound, wherefore I divide 2640 (the given *number*) by 20, and the *Quotient* is 132, and so many *pounds* are contained in 2640 *shillings*. In Reduction descending and ascending the Learner is advised to take particular notice of the Tables delivered in the second Chapter of this Book, where he may be informed what *Multipliers* or *Divisors* to make use of in the reducing of any Number to any other Denomination whatsoever, especially *English* Moneys, Weights, Measures, Time and Motion; but in this place it is not convenient to meddle with Foreign Coyns, Weights, or Measures.

```
                 I.
2|0) 264|0 (132
     ...
     2
     ---
     6
     6.
     ---
     4
     4
     ---
     (0)
```

But if in Reduction Ascending it happen that there is a denomination or denominations between the *number* given, and the *number* required, then you may *reduce* your *number* given into the next *superiour* denomination, and when it is so reduced, bring it into the next above that, and so on until you have brought it into the Denomination required. As for Example,

Let it be demanded in 126720 *farthings*, how many *pounds*? First, I divide my given *number* (being *farthings*) by 4, to bring them into *pence*, (because 4 *farthings* make one *penny*) and they are 31680 *pence*, then I divide 31680 *pence* by 12, and the *quotient* giveth 2640 *shillings*, and then I divide 2640 *shillings* by 20, and the *quotient* giveth 132 *pounds*, which are equal in value to 126720 *farthings*. See the whole Work as it followeth.

		12)	20)	l.
4)	126720	(31680	(264|0	(132
	.....	...	..	
	12	24	2	
	6	76	6	
	4	72	6	
	27	48	4	
	24	48	4	
	32	(0)	(0)	
	32			
	(0)			

7. When the *number* given to be reduced, consisteth of divers denominations, as *pounds*, *shillings*, *pence* and *farthings*, or of *hundreds*, *quarters*, *pounds* and *ounces*, *&c.* then you are to reduce the higheſt (or greateſt) denomination into the next *Inferiour*, and add thereunto the *number* ſtanding in that denomination which your greateſt or higheſt *number* is reduced to; then reduce that *Sum* into the next *inferiour* Denomination, adding thereto the *number* ſtanding in that denomination; do ſo until you have brought the *number* given into the denomination propoſed. As if it were required to reduce 48 *l.* 13 *s.* 10 *d.* into *pence*; firſt, I bring 48 *l.* into *ſhillings*, by multiplying it by 20, and the *product* is 960 *ſhillings*, to which I add the 13 *ſhillings*, and they make 973, then I multiply 973 by 12, to bring the *ſhillings* into *pence*, and they make 11676 *pence*, to which I add the 10 *pence*, and they make 11686 *pence* for the Anſwer, ſee the Work done.

48 *l.*

l.	*s.*	*d.*
48	13	10

20

960 *ſhillings*
Add 13
Sum 973 *ſhillings*
12

1946
973

11676 *pence*
Add 10

Sum 11686 *pence*

8. If (in Reduction Aſcending) after Diviſion is ended, any thing remain, ſuch Remainder is of the ſame Denomination with the Dividend.

Example. In 4783 *farth.* I demand how many *pounds.* Firſt, I divide the given *number* of *Farthings*, (*viz.* 4783) by 4 to bring them into *pence*, and the Quotient is 1195 *pence*, and there remaineth 3 after the work of Diviſion is ended, which is 3 *farthings.*

Again, I divide 1195 *pence* (the ſaid *Quotient*) by 12, to reduce them into *ſhillings*, and the *Quotient* is 99 *ſhillings*, and there is a Remainder of 7, which is 7 *pence.*

And then I divide 99 *ſhillings* (the laſt *Quotient*) by 20, to bring it into *pounds*, and the *Quotient* is 4 *l.* and there remaineth 19 *ſhillings*; ſo that I conclude that in 4783 (the propoſed *number* of *farthings*) there is 4 *pounds*, 19 *ſhillings*, 7 *pence*, 3 *farthings*, view the following Operation.

```
                  12          2|0)  (4 pounds
4) 4783          (1195        9|9
   ....            ..
   4              108          8|
   ---            ---          ---
   07             115          (19) shillings
    4             108
   ---            ---
    38   Rem. (7) pence
    36
   ---                 l.   s.   d.  qrs.
    23          facit 04—19—07—03
    20
   ---
Remains (3) farthings
```

More Examples in Reduction of Coin.

Quest. 1. In 438 *l.* how many *shillings*? *Facit* 8760 *shillings*, for by multiplying 438 by 20, the *Product* amounteth to so much. See the Work.

```
   438 pounds
    20
  ----
Facit 8760 shillings
```

Quest. 2. In 467 *l.* how many *Pence*? First, multiply the given *number* of *pounds* (467) by 20 to bring it into shillings, and it makes 9340 *shillings*, then multiply the *shillings* by 12, and it produceth 112080 *pence*, thus,

```
   467 pounds
    20
  ----
  9340 shillings
    12
  -----
 18680
 9340
 -----
Facit 112080 pence
```

Or it may be resolved thus, *viz.* multiply the given *number* of *pounds* (467) by (240) the *number* of *pence* in a *pound*, and the Product is the same, *viz.* 112080 *pence*, as by the Operation appeareth.

467 *pounds*
240

18680
934

Facit 112080 *pence*

Quest. 3. In 5673 *l.* how many *farthings*? First, Multiply the given *number* by 20, to bring it into *shillings*, and it produceth 113460 *shillings*, then multiply that *product* by 12, to bring it into *pence*, and it produceth 1361520 *pence*; then lastly, multiply the *pence* by 4, and it produceth 5446080 *farthings*. See the Operation.

5673 *pounds*
20

113460 *shillings*
12

226920
113460

1361520 *pence*
4

Facit 5446080 *farthings*

Or this Question might have been thus resolved, *viz.* Multiply 5673 (the given *number* of *pounds*) by 960 (the *number* of *farthings* in a *pound*) and it produceth the same Effect, as you may see by the Work.

5673

5673	*pounds*	20	*shillings*
960		12	
340380		240	*pence*
51057		4	
Facit 5446080	*farthings*	960	*farthings*

Otherwise thus; First bring the given *number* 5673 *l.* into *shillings*, and multiply the *shillings* by 48, the *number* of *farthings* in a *shilling*, and the same Effect is thereby likewise produced, *viz.*

5673	*pounds*	12	*pence*
20		4	
113460	*shillings*	48	*farth.*
48			
907680			
543840			
Facit 5446080	*farthings*		

These various ways of Operating are expressed to inform the Judgment of the Learner, with the Reason of the Rule; more ways may be shown, but these are sufficient even for the meanest Capacities.

Quest. 4. In 458 *l.* 16 *s.* 7 *d.* 3 *qrs.* how many *farthings?* To Resolve this Question consider the seventh Rule of this Chapter, and work as you are there directed, and you will find the aforesaid given *number* to amount to 440479 *farthings*, *viz.*

l.	s.	d	qrs.
458	—16	—07	—3

20

9160 *ſhillings*
Add 16

Sum 9176 *ſhillings*
12

18352
9176

110112 *pence*
Add 07

Sum 11019 *pence*
4

440476 *farthings*
Add 3

Sum 440479 *farthings.*

This laſt Queſtion (or any other of this kind, *viz.* where the *number* given to be reduced conſiſteth of ſeveral Denominations) may be more conſiſely reſolved thus, *viz.* when you multiply the pounds by 20, to bring them into ſhillings, to the product of the firſt Figure, add the Figure ſtanding in the place of Units in the Denomination of ſhillings, but becauſe the firſt Figure in the Multiplier is (o) I ſay o times 8 is nothing, but 6 is 6, which I put down for the firſt Figure in the product, then becauſe this Multiplier is o, I go on no further with it, for if I ſhould, the whole Product would be o, but proceed, and when I come to multiply by the ſecond Figure in the Multiplier, and to the Product of it, I add the Figure ſtanding in the place of Tens in the Denomination of ſhillings which

is (1) saying 2 times 8 is 16, and (the said Figure) 1 is 17, then I set down 7, and carry a Unit to the Product of the next Figure, as is directed in the fifth Rule of the sixth Chapter foregoing; and finish the Work. So that you now have the whole Product and Sum of shillings at one operation, which is the same as before, and when you multiply the shillings by 12, to bring them into pence (after the same manner) add to the Product the number standing in the denomination of pence, and so when you multiply the pence by 4 to bring them into farthings, add to the Product the number standing under the Denominations of Farthings. See the last Question thus wrought.

l.	s.	d.	qrs.
458	16	07	3
20			
9176 *shillings*			
12			
18359			
9176			
110119 *pence*			
4			

Facit 440479 *farthings.*

After the Method last prescribed (which if Rightly considered, differeth not any thing from the 7*th.* Rule of this Chapter) are all the following Examples that are of the same nature wrought and resolved.

Quest. 5. In 4375866 Farthings, I demand how many Pounds, Shillings, Pence, and Farthings?

To resolve this Question; First, I divide the given number of Farthings by 4, and the Quotient is 1093966 Pence, and there Remaineth 2 after the Division is ended, (which by the 8*th.* Rule foregoing) is two Farthings; then I divide 1093966 Pence by 12 and the Quotient

Quotient is 91163 Shillings, and there remaineth 10 after Diviſion, which by the ſaid 8*th.* Rule is ſo many Pence, *viz.* 10 *d.* then I divide 91163 Shillings by 20, and the Quotient is 4558 *l.* and there remaineth 3 Shillings; ſo the work is finiſhed, and I find that in 4375866 Farthings there are 4558 *l.* 03 *s.* 10 *d.* 2 *qrs.* See the Operation,

		12)	2|0	l.
4)	4375866	(1093966	(9116|3	(4558
	4	108	8	
	37	13	11	
	36	12	10	
	15.	19	11	
	12	12	10	
	38	76	16	
	36	72	16	
	26	46	(03) *ſhillings*	
	24	36		
	26	(10) *pence*		
	24			
	(2) *farthings*			

	l.	s.	d.	qrs.
Facit	4558	03	10	2

Queſt. 6. In 4386 *l.* I demand how many Groats? To Reſolve this Queſtion, I reduce the given number of Pounds into Shillings, and they are 87720 Shillings; now I conſider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats. See the Work.

4386 *pounds*
20
87720 *ſhillings*
3
Facit 263160 *groats*

This Queſtion might have been otherwiſe reſolved thus, *viz.* conſidering that in a Pound (or 20 Shillings) there are 3 times 20 Groats, which make 60, by which I multiply the number of Pounds given, and it produceth the ſame Effect at one Operation, as followeth.

4386 *pounds*	20
60 *groats in* 20 *s.*	3
Facit 263160 *groats in* 4386 *l.*	60

Queſt. 7. In 43758 three Pences, I deſire to know how many Pounds?

To reſolve this (and many ſuch like) Queſtion; Firſt, I divide my given number of Pences by 4, becauſe 4 three Pences are in a Shilling, and the Quotient is 10939 ſhillings; and there remaineth 2 after Diviſion is ended, which is 2 three Pences (by the 8*th.* Rule of this Chapter) which are equal in value to 6 *d.* then I divide 10939 Shillings by 20, and the quote giveth 546 *l.* and 19 *s.* Remain; ſo that I conclude in 43758 pieces of three pence *per* piece, there are 546 *l.* 19 *s.* 06 *d.* as by the Work appeareth.

2|0 l. s. d.
4) 43758 (1093|9 (546—19—06
• • • • • • •
4 10
37 9
36 8
15 13
12 12
38 19 *shillings*
36
(2) *three pences, or* 6 d.

This Question might have been otherwise Resolved thus, *viz.* first multiply the given Number of three pences 43758, by three the Number of pence in three pence, and the product (*viz.* 131274) is the Number of pence equal to the given Number of three pences, which number of pence may be brought into pounds by dividing by 12 and by 20, and the Quotient you will find to be equal to the former work, *viz.* 546 *l.* 19 *s.* 6 *d.*

43758
3
2|0 l. s. d.
12) 131274 (1093|9 (546—19—06
• • • • • • • • •
12 10
112 9
108 8
47 13
36 12
114 *rem.* (19) *shillings.*
108

Or thus, divide the given *Number* of 3 pences by the *number* of 3 pences in a pound or 20 ſhillings (which you will find to be 80, if you multiply 20 *s.* by 4, the *number* of three pences in a ſhilling) and you will find the quote to be 546 *l.* as before, and a Remainder of 78 three pences, and if you divide thoſe 78 three pences by 4, (becauſe there are 4 three pences in a ſhilling) you will find the quote to be 19 *s.* and 2 three pences Remain, which are equal to 6 *d.* which is the ſame that was before found.

```
                    l.   s.   d.
8|0) 4375|8 (546—19—06                20
     ...                                4
     40                                ——
    ——                                 80
     37
     32
    ——
     55
     48
    ——  s.
  4) 78 (19
     ..
      4
    ——
     38
     36
    ——
```

(2) *three pences or 6 d.*

Queſt. 8. In 4784 *l.* 13 *s.* how many pieces of $13\frac{1}{2}$*d.* *per* piece?

This Queſtion cannot be reſolved by Reduction, deſcending, or aſcending, abſolutely, becauſe $13\frac{1}{2}$*d.* is no even part of a pound) but rather by them both jointly, *viz.* by Multiplication and Diviſion; for if you bring the number given into half pence, and divide the half pence, by the half pence in $13\frac{1}{2}$*d.* *viz.* 27, the quotient will be the Anſwer; for having

brought 4785 *l.* 13 *s.* into half pence, I find it makes 2297112, which I divide by 27, (becauſe there are ſo many half-pence in $13\frac{1}{2}$*d.*) and the quote gives 85078 pieces of $13\frac{1}{2}$*d.* and 6 half pence remain over and above; obſerve the work following.

l.	s.	d.
4785	—13	$13\frac{1}{2}$
20		2
95713	*ſhillings*	27 *half-pence*
24	*half-pence in a ſhilling*	
382852		
191426		

2297112 *half-pence in the given number.*

d.

27) 2297112 (85078 *pieces of* $13\frac{1}{2}$

216

137
135

211
189

222
216

Remain (6) *half-pence*

It would have produced the ſame anſwer if you had reduced your given number into farthings, and divided by the farthings in $13\frac{1}{2}$*d. viz.* 54. (for always the Dividend and the Diviſor muſt be of one Denomination) and then you would have had a Remainder of 12 farthings, which are equal in value to the former Remainder of 6 half-pence, as you may

Queſt. 9. In 540 Dollars at 4 *s.* 4 *d. per* Dollar how many pounds *ſterling?*

Firſt, Bring your given Number of Dollars into Pence, and then your Pence into Pounds according to the former Directions. Thus in 4 *s.* 4 *d.* (*viz.* a Dollar) you will find 52 pence, by which multiply 540 Dollars, and it produced 28080 pence, which if you divide by 240 (the pence in one pounds) the quotient will give you 117 *l.* which are equal in value to 540 dollars, at 4 *s.* 4 *d. per* dollar obſerve the Operation.

	s. d.
540	4—4
52	12
1080	52 *pence*
2700	
l.	
240) 28080 (117	
24	
40	
24	
168	
168	
(0)	

The foregoing Queſtion might have been otherwiſe wrought, thus, *viz.* Multiply (540) your given number of Dollars, by 13 the number of Groats in a Dollar (or 4 *s.* 4 *d.*) and it produceth 7020 groats, which divide by 60 (the groats in 1 pound or 20 ſhillings) and the quote is 117 *l.* as before. See the Work.

```
                    s. d.
     540            4—4
      13            3
    ----           ----
    1620           13
    540
6|0)702|0(117
    .
    6
    ---
    10
     6
    ---
    42
    42
    ---
    (0)
```

Quest. 10. In 547386 pieces of 4 $\frac{1}{2}$*d.* *per* piece, I demand how many Pounds, Shillings, and Pence?

First, Bring your given number of four pence half-penies all into half-pence, which you will do if you multiply by 9 the number of half-pence in 4 $\frac{1}{2}$*d.* and the product is 4926474 half-pence, which are brought into pounds, if you divide them by 24 (the half-pence in a shilling) and 20 (the shillings in a pound) it makes 10263 *l.* 09 *s.* 9 *d.* as by the Work.

547386

		d.
547386		$4\frac{1}{2}$
9		2

2|0) l. 9 *half pence*

24) 4926474 (20526|9 (10263

48 2

126 05

122 4

64 12 l. s. d.

48 12 *facit* 10263—09—09

167 6

144 6

234 *rem.* (09) *shillings*

216

Rem. (18) *half pence or* 9 d.

Queſt. 11. In 4386 *l.* I demand how many pieces of 6 *d.* of 4 *d.* and of 2 *d.* of each an equal Number? that is to ſay, what Number of Six pences, Groats, and two pences, will make up 4386 *l.* and the Number of each equal?

The way to reſolve queſtions of this Nature, is to add the ſeveral pieces (into which the given Number is to be brought) into one Sum, and to reduce the given Number into the ſame denomination with their Sum, and to divide the ſaid given Number (ſo Reduced) by the ſaid Sum, and the Quotient will give you the exact Number of each piece. And after the ſame Method will we proceed to Reſolve the preſent Queſtion, *viz.*

```
     4386 pounds                    6
      240 pence                     4
     ------                         2
     175440                        ---
     8772                      Sum 12 pence
     ------
12)  1052640 (87720
     .....
     96
     ---
     92
     84
     ---                          d.  d.  d.
     86 facit 87720 pieces of     6—4—2
     84
     ---
     24
     24
     ---
     (0)
```

So that I conclude by the operation that 87720 six pences, and 87720 groats, and 87720 two pences are just as much as (or equal to) 4386 *l.* or if you admit of 5 *s.* to be thus divided, it is equal to 5 six pences, and 5 four pences or Groats, and 5 two pences. *For if two Right lines (or two Numbers) be given, and one of them be divided into as many Parts, or Segments as you please, the Rectangle (or Product) comprehended under the two whole Right lines (or numbers given) shall be equal to all the Rectangles (or Products) contained under the whole line (or Number) and the several Segments (or Parts) into which the other line (or Number) is divided*, Eucl. 2. 1.

Another Question of the same Nature with the last may be this following, *viz.*

Quest. 12. A Merchant is desirous to Change 148 *l.* into pieces of 13 *d* $\frac{1}{2}$. of 12 *d.* of 9 *d.* of 6 *d.* and of 4 *d*; and he will have of each sort an equal Number of pieces, I desire to know the number?

Do as you were taught in the last question, *viz.* add the several pieces together, and reduce the Sum

into half-pence, then reduce the Sum to be changed, *viz.* 148 *l.* into the same denomination, and divide the greater by the lesser, and in the Quotient you will find the Answer, *viz.* 798 is the Number of each of the pieces required, and 18 remaineth, which is 18 half-pence by the 8*th.* Rule of this Chapter. See the work as followeth.

l.		d.
148		13 $\frac{1}{2}$
240	*pence in a* l.	12
5920		9
296		6
		4
35520	*pence in* 148 l.	*Sum* 44
2		2 $\frac{1}{2}$
71040	*half pence*	89 *half-pence.*

89) 71040 (798 *pieces of each sort*

623

874
801

730
712

Remain (18) *half-pence*

The truth of the two foregoing Operations will thus be proved, *viz.* multiply the Answer by the parts, or pieces into which the given Number was reduced, and having added the several Products together, if their Sum be equal to the given Number, the Answer is Right, otherwise not.

So the Answer to the 11*th.* Question was 87720, which is proved as followeth, *viz.*

		l.
87720	*Six-pences make*	2193
	Four-pences make	1462
	Two-pences make	731
	The total Sum of them	4386 *which was the Sum given to be changed.*

The Answer to the 12*th.* Question was 798, and 18 half pence remained after the Work was ended, now the truth of the work may be proved as the former was, *viz.*

			l.	s.	d.
798	*Pieces of* 13½	*make*	44	17	09
	Pieces of 12	*make*	39	18	00
	Pieces of 9	*make*	29	18	06
	Pieces of 6	*make*	19	19	00
	Pieces of 4	*make*	13	06	00
and 18 *half-pence, or* 9 d.		*remains*	00	00	09
	The Total Sum of them		148	00	00

which Total Sum is equal to the Number that was first given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy-weight.

We come now to give the Learner some Examples in *Troy-weight*, wherein we shall be brief, having given so large a Taste of *Reduction* in the foregoing Examples of Coyn, and now the Learner must be mindful of the Table of *Troy-weight* delivered in the second Chapter of this Book.

Quest. 13. In 482 *l.* 07 *oz.* 13 *p. w.* 21 *gr.* how many Grains?

Multiply by 12, by 20, and by 24, taking in the Figures standing in the several denominations, according to the Direction given in the 7*th.* Rule of this Chapter, and you will find the Product to be 2780013 Grains, which is the Number required, or Answer to the Question. See the whole work as followeth.

l. *oz.* *p.w.* *gr.*
482—07—13—21
12

971
482

5791 *ounces*
20

115833 *penny weight*
24

463333
231668

Facit 2780013 *grains*

Queſt. 14. In 2780013 *grains*, I demand how many Pounds, Ounces Penny-Weights, and Grains?

This is but the foregoing Queſtion inverted, and is reſolved by dividing 24 by 20, and by 12, and the Anſwer is 482 *l.* 07 *oz.* 13 *p.w.* 21 *gr.*

	2|0)	12)	*l.*
24) 2780013	(11583|3	(5791	(482
24	10	48	
38	15	99	
24	14	96	
140	18	31	
120	18	24	
200	3 *Rem.*	(7) *ounces.*	
192	2		
81 *Rem.*		(13 *penny weight*	
72			
93		*l.* *oz.* *p.w.* *gr.*	
72	*facit*	482—07—15—21	

Queſt. 15. A Merchant ſent to a Goldſmith 15 Ingots of Silver each containing in weight 2 *l.* 4 *oz.* and ordered it to be made into Bowls of 2 *l.* 8 *oz. per* Bowl, and Tankards of 1 *l.* 6 *oz. per* piece, and Salts of 10 *oz.* 10 *p.w. per* Salt, and Spoons of 1 *oz.* 18 *p.w. per* Spoon; and of each an equal number, I deſire to know how many of each ſort he muſt make?

This Queſtion is of the ſame Nature with the 11 and 12 Queſtions foregoing, and may be anſwered after the ſame Method, *viz.* Firſt, add the weight of the ſeveral Veſſels (into which the Silver is to be made) into one Sum, and reduce it to one Denomination, and they make 1248 *penny weights*, then reduce the weight of the Ingot into the ſame denomination, *viz. penny weights*, (and it makes 560 *penny weights*) and multiply them by the Number of Ingots, *viz.* 16, and the product will give you the weight of the 16 Ingots, *viz* 8960, then divide this product by the weight of the Veſſels, *viz.* 1248, and the Quotient giveth you the Anſwer to the Queſton, *viz.* 7. and 224 *p.w.* remaining over and above.

l.	*oz.*
2	4
12	
28	
20	
560	*penny weights*
16	*Ingots*
3360	
560	
8960	

1248) 8960 (7 *Veſſels of each*
8736

Rem. (224) *penny weights.*

l.	*oz.*	*p.w.*
2	08	00
1	06	00
0	10	10
0	01	18
Sum 5	02	08
12		
011		
62		
20		
1248	*p.weights*	

The Proof of the Work is as followeth, viz.

			l.	*oz.*	*p.w.*
7	*Bowls of* 2—08—00	*per Bowl is*	18—	08—	00
	Tank. of 1—06—00	*per Tank. is*	10—	06—	00
	Salts of 0—10—10	*per Salt is*	06—	01—	10
	Spoons of 0—01—18	*per Spoon is*	01—	11—	04
	224 *penny weight remaining is*		00—	11—	04
		Total Sum	37—	04—	00

So that you see the Sum of the Weights of each Vessel, together with the Remainder is 37 *l.* 4 *oz.* which is equal to the Weight of the 16 Ingots delivered. For if 37 *l.* 04 *oz.* be reduced to Penny Weights, it makes 8960.

Reduction of Averdupois Weight.

In Reducing *Averdupois weight*, the Learner must have Recourse to the Table of *Averdupois weight* delivered in the 2*d.* Chapter foregoing.

Quest. 16. In 47 *C.* 1 *qr.* 20 *l.* how many Ounces?

Multiply by 4, by 28, and by 16, and the last Product will be the Answer, *viz.* 84992 Ounces.

C. qrs. d.
47—1—20
4

189 *quarters*
28

1512
380

5312 *l.*
16

31872
5312

Facit 84992 *ounces*

Queſt. 17. In 84992 Ounces, I demand how many *C. qrs. l. oz.*

This is the foregoing Queſtion Inverted, and will be Reſolved if you divide by 16, by 28, and by 4, and the Anſwer is 47 *C.* 1 *qr.* 20 *l.* equal to the given Number in the foregoing Queſtion.

16)	84992	28)	(5312	4)	(189	*C.*	*qrs.*	*l.*	*oz.*
	80		28		16	(47—	1—	20—	00
	49		251		29.				
	48		224		28				
	19		272		(1) *quarter*				
	16		252						
	32		(20) *pounds*						
	32								
	(00)								

Queſt. 18. A Chapman buyeth of a Grocer 4*C.* 1*qr.* 14 *l.* of Pepper, and ordered it to be made up into Parcels of 14 *l.* of 12 *l.* of 8 *l.* of 6 *l.* and of 2 *l.* and of each Parcel an equal number, now I would know the number of each parcel.

This Example is of the ſame nature with the 11, and 12, and 15 Queſtions foregoing, and after the ſame manner is reſolved. See the Operation as followeth.

4 *C.*

C.	*qrs.*	*l.*
4	1	14
4		
17		
28		
140		
35		

42)490(11
42
70 *Facit* 11 *parcels of each.*
42
Rem. (28) *pounds*

l.
14
12
8
6
2

42 *pounds*

Reduction of Liquid Measure.

Queſt. 19. In 45 *Tun* of Wine, how many *Gallons?* Multiply by 4, and by 63 the product is 11350 Gallons for the Anſwer.

45
4
180
63
540
1080

Facit 11340 *gallons*

Queſt. 20. In 34 Rundlets of Wine, each containing 18 Gallons, I demand how many Hogſheads?

Firſt, Find how many Gallons is in the 34 Rundlets, which you may do if you multiply 34 by 18, the content of a Rundlet, and the Product is 612 Gallons,

which

which you may reduce into Hogſheads if you divide them by 63, and the Quote will be 9 Hogſheads, and 45 Gallons. See the Work.

34
18

272
34

63) 612 (9 *Hhds.*

567

Remain (45) *gallons*

facit 9 *Hhds* 45 *gallons.*

Queſt. 21. In 12 Tun how many Rundlets of 14 Gallons *per* Rundlet?

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Rundlet, and the Quotient (216) is your Anſwer. See the Work following.

12
4

48
63

144
288

14) 3024 (216 *rundl.*

28

22
14

84
84

(0) *facit* 216 *rundlets*

Reduction of Long Measure.

Queſt. 22. I demand how many Furlongs, Poles, Inches and Barley Corns will reach from *London* to *York*, it being accounted an 151 Miles?

151 *miles*
8 *furlongs in a mile*

1208 *furlongs*
40 *poles in a furlong*

48320 *poles*
11 *half yards*

48320
48320

531520 *half yards*
18 *inches in half a yard*

4252160
531520

9567360 *inches*
3 *barley corns in an inch*

Facit 28702080 *barley corns in* 151 *miles*

Queſt. 23. The Circumference of the Earth (as all other Circles are) is divided into 360 Degrees, and each degree into 60 Minutes, which (upon the Superficies of the Earth) are equal to 60 miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet, and Barley-Corns will reach round the Globe of the Earth?

360

360	*degrees*
60	*minutes or miles in a degree*
21600	*miles about the Earth*
8	*furlongs in a mile*
172800	*furlongs about the Earth*
40	*perches in a furlongs*
6912000	*poles or perches about the Earth*
11	*half yards in a perch*
6912000	
6912000	
2) 76032000	*half yards about the Earth*
(38016000	*yards*, viz. *the half yards*
3	*divided by* 2.
114048000	*feet about the Earth*
12	*inches in a foot*
228096000	
114048000	
1368576000	*inches about the Earth*
3	*barly-corns in an inch*
facit 4105728000	*barly-corns.*

And ſo many will reach round the World, the whole being 21600 Miles, ſo that if any Perſon were to go Round, and go 15 Miles every Day, he would go the whole Circumference in 1440 Days which is 3 Years, 11 Months, and 15 Days.

Reduction of Time.

Queſt. 24. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes?

years	*weeks*	*days*	*hours*	*min.*
28	24	4	16	30

52 *Weeks in a year.*

60
142

1489 *Weeks*
7

10364 *Days*
24

41462
20729

248752 *Hours*
60

14925150 *minutes*

Note, That in Reſolving the laſt Queſtion after the Method expreſſed, there is loſt in every year 30 Hours, for the Year conſiſteth of 365 Days and 6 Hours, but by multiplying the Years by 52 Weeks, which is but 364 Days; You loſe 1 Day and 6 Hours every Year, wherefore to find an exact Anſwer, bring the odd Weeks, Days, and Hours into Hours, and then multiply the Years by the Number of Hours in a Year, *viz.* 8766, and to the Product add the Hours contained in the odd time, and you have the exact time in hours, which bring into Minutes as before. See the laſt Queſtion thus reſolved.

		weeks days hours
		24—4—16
		7
	days, hours	172
28	365—6	24
8766	24	
		694
172	1466	345
172	730	
197		4144 *hours*
228	8766 *hours in a year*	
249592 *hours*		
60		

14975520 *Minutes in* 28 *years and* 4144 *hours.*

So you see that according to the Method first used to resolve this Question, the Hours contained in the given time are 248752, but according to the last, best, or true Method, they are 249592 which exceeds the former by 840 hours.

But for most occasions it will be sufficient to multiply the given years by 365, and to the Product add the days in the odd time, if there be any, and then there will be only a loss of 6 hours in every year, which may be supplied by taking a fourth part of the given years, and adding it to the contained days, and you have your desire.

Quest. 25. In 438657540 Minutes, how many years? *Facit* 834 *years*, 4 *dayes*, 19 *hours.*

8766)

8766) *yea. days hou.*

6|0) 43865754|0 (7310959 (834——4——19

42 70128

18 29815
18 26298

6 35179
6 35064

57 *days*
54 24) 115 (4
96

35 *Rem.* (19) *hours*
30

54
54

(0)

Queſt. 26. I deſire to know how many hours and minutes it is ſince the Birth of our Saviour Jeſus Chriſt to this preſent year, being accounted 1677 years?

This Queſtion is of the ſame nature with the 24*th.* foregoing and after the ſame manner is reſolved, *viz.* Multiply the given number of years by 8766, the product is 14700582 hours, and that by 60, and the product is 882034920 Minutes. See the work.

1677 *years*
8766 *hours in a year*

10062
10062
11739
13416

14700582 *hours in* 1677 *years*
60

882034920 *minutes in* 1677 *years*

Note that as Multiplication and Diviſion do interchangeably prove each other, ſo Reduction Deſcending and Aſcending, prove each other by Inverting the Queſtion, as the 13 and 14, and likewiſe the 16 and 17 Queſtions foregoing, by Inverſion, do interchangeably prove each other, the like may be performed for the proof of any Queſtion in Reduction whatſoever.

Thus far have we diſcourſed concerning ſingle Arithmetick, whoſe Nature and Parts are defined in the ſecond, eighth, ninth, and tenth definitions of the third Chapter of this Book, for although Reduction is not reckoned or defined among the parts of ſingle Arithmetick, yet conſidered Abſtractly, it is the proper effect of Multiplication and Diviſion; and as for the extraction of Roots (which ought to be handled in the next place as parts of ſingle Arithmetick) we ſhall omit it in this place, and refer the Learner to Mr. *Cockers* Decimal Arithmetick, which is (with great care and pains) now publiſhed, together with his Logarithmetical Arithmetick, ſhewing the Geneſis or Fabrick of the Logarithms, and their general uſes in Arithmetick, *&c.* As alſo his Algebraical Arithmetick, containing the Doctrine of compoſing and reſolving an Equation, with all other Rules neceſſary for the underſtanding of that Myſterious Art, *&c.*

CHAP. IX.

Of Comparative Arithmetick, viz. *The Relation of* Numbers *one to another.*

1. COmparative Arithmetick is that which is wrought by Numbers, as they are conſidered to have relation one to another, and this conſiſts either in Quantity, or in Quality. *Boetius Arith. lib. 1. cap. 21.*

2. Relation

2. Relation of Numbers in Quantity, is the Reference or Respect, that the Numbers themselves have one to another, where the Terms or Numbers propounded are alwayes two, the first called the Antecedent, and the other the Consequent. *Vide Wing. Arith. cap.* 34.

3. The Relation of Numbers in Quantity consists in the Differences, or in the rate or reason that is found betwixt the Terms propounded, the difference of two Numbers being the Remainer found by Substraction, but the rate or reason betwixt two Numbers is the Quotient of the Antecedent divided by the Consequent. So 21 and 7 being given, the difference betwixt them will be found to be 14, but the rate or reason that is betwixt 21 and 7 will be found to be triple reason, for 21 divided by 7 quotes 3, the reason or rate. *Alsted. Mathemat. lib.* 2. *cap.* 11. *&* 12.

4. The relation of Numbers in Quality, (otherwise called *Proportion*) is the Reference or Respect that the Reason of Numbers have one unto another; therefore the Terms given ought to be more than two. Now this *Proportion* or Reason between Numbers relating one to another, is either Arithmetical, or Geometrical. *Alsted. Math. lib.* 2. *cap.* 21.

5. Arithmetical *Proportion* (by some called *Progression*) is when divers Numbers differ one from another by equal Reason, that is, have equal differences.

So this Rank of Numbers, 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reason, *viz.* by 2, as you may prove.

2. In a Rank of Numbers that differ by Arithmetical *Proportion*, the sum of the first and last term, being multiplyed by half the Number of Terms, the product is the total sum of all the Terms.

Or if you multiply the number of the Terms by the half sum of the first and last Terms, the product thereof will be the total sum of all the Terms.

So in the former *Progression* given, 3 and 17 is 20, which multiplied by 4 (*viz.* half the number of Terms)

the product gives 80, the sum of all the Terms; or multiply 8 (the Number of Terms) by 10 (half the sum of the first and last Terms) the product gives 80 as before.

So also 21, 18, 15, 12, 9, 6, 3, being given, the sum of all the Terms will be found to be 84; for here the Number of Terms is 7, and the sum of the first and last (*viz.* 21 and 3) is 24, half whereof, (*viz.* 12) multiplyed by 7 produceth 84, the sum of the Terms sought.

7. Three Numbers that differ by Arithmetical Proportion, the double of the mean (or middle number) is equal to the sum of the Extreams.

So 9, 12, and 15 being given, the double of the mean 12 (*viz.* 24) is equal to the sum of the Extreams 9 and 15.

8. Four Numbers that differ by Arithmetical Proportion (either continued or interrupted) the sum of the two Means is equal to the sum of the two Extreams.

So 9, 12, 18, 21, being given, the sum of 12 and 18 will be equal to the sum of 9 and 21, *viz.* 30; also 6, 8, 14, 16, being given, the sum of 8 and 14, is equal to the sum of 6 and 16, *viz.* 22, *&c.* *Vide Wing. Arith. cap.* 35.

9. Geometrical Proportion (by some called Geometrical Progression) is when divers numbers differ according to like Reason.

So 1, 2, 4, 8, 16, 32, 64, *&c.* differ by double Reason, and 3, 9, 27, 81, 243, 729, differ by triple Reason, 4, 16, 64, 256, *&c.* differ by quadruple reason, *&c.*

10. In any numbers that increase by Geometrical proportion, if you multiply the last Term by the Quotient of any one of the terms divided by another of the Terms, which being less is next unto it, and having deducted, or substracted, the first Term out of that Product, divide the remainder by a number that is an unit less than the said Quotient, the last quote will give you the sum of all the Terms.

So 1, 2, 4, 8, 16, 32, 64, being given, first I take one of the Terms, *viz.* 8, and divide it by the Term which is less and next to it, (*viz.* by 4) and the Quotient is 2, by which I multiply the last term 64, and the Product is 128, from whence I substract the first term (*viz.* 1.) the Remainder is 127, which divided by the Quotient 2 made less by 1 (*viz.* 1.) the quote is 127, for the sum of all the given *terms*, as by the Work in the Margent.

64
4) 8 (2
128
1
1) 127 (127

So if 4, 16, 64, 256, 1024, were given, the sum of all the *terms* will be found to be 1634. For first, I divide 64 one of the terms by his next lesser term, and the Quotient is 4, by which I multiply the last term 1024, and it produceth 4096; from whence I substract the first term 4, and the Remainder is 4092, which I divide by the quote less 1 (*viz.* 3.) and the quote is 1364, for the total sum of all the Terms, as *per* Margent.

1024
16) 64 (4
4096
4
3)4092(1364

So likewise if 2, 6, 18, 54, 162, 486, were given the Sum or Total of all the Terms will be found to be 728. See the Work.

486
6) 18 (3
1458.
2
2) 1456 (728

11. Three Geometrical Proportionals given, the Square of the Mean is equal to the Rectangle, or Product of the Extreams.

So 8, 16, 32 being given, the Square of the Mean, *viz.* 16 is 256, which is equal to the Product of the Extreams 8 and 32, for 8 times 32 is equal to 256.

12. Of 4 Geometrical Proportional numbers given, the Product of the two Means is equal to the Product of the two Extreams.

So 8, 16, 32, 64, being given, I say that the product of the two Means, *viz.* 16 times 32, which is 512 is equal to 8 times 64, the product of the Extreams.

Alſo if 8, 9, 21, 69, were given (which are interrupted) I ſay 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariſeth that precious Gem in Arithmetick, which for the Excellency thereof is called the *Golden Rule*, or *Rule of Three*,

CHAP. X.

The Single Rule of Three Direct.

1. THE Rule of Three (not undeſervedly call'd the Golden Rule) is, that by which we find out a fourth *number*, in *proportion* unto *three* given *Numbers*, ſo as this *fourth Number* ſought may bear the ſame Rate, Reaſon, or Proportion to the *third* (given) *number*, as the ſecond doth to the firſt, from whence it is alſo called the Rule of *Proportion*.

2. Four *Numbers* are ſaid to be *Proportional*, when the firſt containeth or is contained by the ſecond, as often as the third containeth, or is contained by the fourth. *Vide Wingates Arith. Chap. 8. Sect. 4.*

So theſe *Numbers* are ſaid to be *Proportionals*, *viz.* 3, 6, 9, 18, for as often as the firſt *Number* is contained in the ſecond, ſo often is the third contained in the fourth, *viz.* twice. Alſo 9, 3, 15, 5, are ſaid to be *Proportional*, for as often as the firſt *Number* containeth the ſecond, ſo often the third *number* containeth the fourth, *viz.* 3 times.

3. The Rule of Three is either ſimple or compoſed.

4. The ſimple (or ſingle) Rule of *Three*, conſiſteth of 4 *Numbers*, that is to ſay, it hath 3 *Numbers* given to find out a fourth; and this is either Direct, or Inverſe. *Vide Alſted. Math. lib. 2. cap. 13.*

5. The ſingle Rule of *Three direct*, is when the *Proportion* of the firſt *term* is to the ſecond, as the third is to the fourth; or when it is required that the *Number*

ſought (*viz.*) the fourth *Number* muſt have the ſame *Proportion* to the ſecond, as the third hath to the firſt.

6. In the Rule of *Three*, the greateſt difficulty is (after the Queſtion is propounded) to diſcover the *order* of the 3 *terms*, *viz.* which is the firſt, which is the ſecond, and which the third, which that you may underſtand, obſerve, That (of the three given *Numbers*) two are always of one kind, and the other is of the ſame kind with the *Proportional Number* that is ſought; as in this Queſtion, *viz.* If 4 yards of Cloth coſt 12 ſhillings, what will 6 yards coſt at that Rate? Here the two *Numbers* of one kind are 4 and 6, *viz.* they both ſignifie ſo many yards; and 12 ſhillings is the ſame kind with the *Number* ſought, for the price of 6 yards is ſought.

Again, obſerve, that of the 3 given *numbers*, thoſe two that are of the ſame kind, one of them muſt be the firſt, and the other the third, and that which is of the ſame kind with the *number* ſought, muſt be the ſecond *number* in the Rule of *three*; and that you may know which of the ſaid *Numbers* to make your firſt, and which your third, know this, that to one of thoſe two *Numbers* there is always affixed a demand, and that *number* upon which the demand lieth muſt always be reckoned the third *Number*. As in the forementioned Queſtion, the demand is affixed to the *number* 6, for it is demanded what 6 yards will coſt? and therefore 6 muſt be the third *number*, and 4 (which is of the ſame denomination (or kind) with it) muſt be the firſt, and conſequently the *number* 12 muſt be the ſecond, and then the *numbers* being plac'd in the forementioned order will ſtand as followeth, *viz.*

yards	*s.*	*yards*
4	12	6

7. In the Rule of *Three Direct* (having placed the *numbers* as is before directed) the next thing to be done will be to find out the fourth *number* in proportion, which (that you may do) multiply the ſecond *number*

by the third, and divide the product thereof by the firſt, (or which is all one) multiply the third *term* (or number) by the ſecond, and divide the product thereof by the firſt, and the Quotient thence ariſing is the *4th number* in a direct proportion, and is the *number* ſought, or Anſwer to the Queſtion, and is of the ſame denomination that the ſecond *number* is of. As thus, let the ſame Queſtion be again repeated, *viz.* If 4 yards of Cloth coſt 12 ſhillings, what will 6 yards coſt?

Having placed my *numbers* according to the *6th* Rule (of this Chapter) foregoing, I multiply (the ſecond *number*) 12, by (the third *number*) 6, and the Product is 72, which Product I divide by (the firſt *number*) 4, and the Quotient thence ariſing is 18, which is the fourth *Proportional* or *number* ſought, *viz.* 18 ſhillings, (becauſe the ſecond *number* is ſhillings) which is the price of the 6 yards, as was required by the Queſtion. See the Work following.

yds.	*s.*	*yds.*	*s.*
If 4	12	6	18

6

4) 72 (18 *ſhillings*

4

32.

32

(o)

Queſt. 2. Another Queſtion may be this, *viz.* If 7 *C.* of *Pepper* coſt 21 *l.* how much will 16 *C.* coſt at that Rate?

To reſolve which Queſtion, I conſider that (according to the *6th* Rule of this Chapter) the *terms* or *numbers* ought to be placed thus, *viz.* the Demand lying upon 16 *C.* it muſt be the third *number*, and that of the ſame kind with it muſt be the firſt, *viz.* 7 *C.* and 21 *l.* (being of the ſame kind with the *number* ſought) muſt be the ſecond *number* in this Queſtion; then I proceed

according

according to this 7*th* Rule, and multiply the ſecond *number* by the third, *viz.* 21 by 16, and the Product is 336, which I divide by the firſt *number* 7, and the Quotient is 48 *l.* which is the value of 16 *C.* of Pepper at the rate of 21 *l.* for 7 *C.* See the Work as followeth.

C.	l.	C.
If 7	21	16

16

126

21

l.

7) 336 (48

28

56

56 *facit* 48 *l.*

(0)

8. If when you have divided the Product of the ſecond and third numbers by the firſt, any thing remain after Diviſion is ended, ſuch Remainder may be multiplyed by the parts of the next inferiour Denomination, that are equal to an Unit (or Integer) of the ſecond number in the Queſtion, and the Product thereof divide by the firſt number in the Queſtion, and the Quotient is of the ſame Denomination with the parts by which you multiplyed the Remainder, and is part of the fourth number which is ſought. And furthermore, if any thing remain, after this laſt Diviſion is ended, multiply it by the parts of the next inferiour denomination equal to an Unit of the laſt Quotient, and divide the Product by the ſame Diviſor (*viz.* the firſt number in the Queſtion) and the quote is ſtill of the ſame denomination with your Multiplyer; follow this Method until you have reduced your Remainder into the loweſt Denomination, *&c.* An Example or two

will make the Rule very plain, which may be this following.

Queſt. 3. If 13 yards of Velvet (or any other thing) coſt 21 *l.* what will 27 yards of the ſame coſt at that Rate?

Having ordered and wrought my Numbers according to the 6 and 7 Rules of this Chapter, I find the Quotient to be 43 *l.* and there is a Remainder of 8, ſo that I conclude the price of 27 *yards* to be more than 43 *l.* and to the intent that I may know how much more, I work according to the foregoing Rule, *viz.* I multiply the ſaid Remainder 8 by 20 *s.* (becauſe the ſecond number in the Queſtion was Pounds) and the product is 160, which divided by the firſt number, *viz.* 13, it quotes 12, which are 12 ſhillings, and there is yet a Remainder of 4, which I multiply by 12 pence, (becauſe the laſt Quotient was ſhillings) and the product is 48, which I divide by 13, (the firſt number) and the Quotient is 3 *d.* and yet there remaineth 9, which I multiply by 4 *farthings*, and the product is 36, which divided by 13 again, it quotes 2 *farthings*, and there is yet a remainder of 10, which (becauſe it cometh not to the value of a *farthing*) may be neglected, or rather ſet (after the 2 *farthings*) over the Diviſor, with a Line between them, and then (by the 21 and 22 Definitions of the firſt Chapter of this Book) it will be $\frac{10}{13}$ of a *farthing*; ſo that I conclude, that if 13 *yards* of Velvet coſt 21 *l.* 27 *yards* of the ſame will coſt 43 *l.* 12 *s.* 03 *d.* 2 $\frac{10}{13}$ *qrs.* which Fraction is 10 thirteenths of a *farthing*. See the Operation as followeth.

yds.	*l.*	*yds.*
If 13	21	27

27

149
42

13) 567 (43 *l.*
52

47
39

Remains (8)
Multiply 20

13) 160 (12 *s.*
13

30
26

Remains (4)
Multiply 12

13) 48 (3 *d.*
39

Remains (9)
Multiply 4

qrs.
13) 36 (2 10/13
26

Remains 10 *facit*	*l.* 43	*s.* 12	*d.* 3	*qrs.* 2 10/13

Queſt. 4. Another Example may be this following, *viz.* If 14 *l.* of *Tobacco* coſt 27 *s.* what will 478 *l.* coſt at that rate?

Work according to the laſt Rule, and you will find it to amount to 921 *s.* 10 *d.* 1 3/14 *qrs.* and by the 5*th*

Rule of the 8*th* Chapter 921 *s.* may be reduced to 46*l.* 01 *s.* So that then the whole worth or value of the 478 *l.* will be 46 *l.* 01 *s.* 10 *d.* 1 $\frac{1}{14}$ *qrs.* the whole Work followeth.

	l.	*s.*	*d.*
If	14	27	478
			27
			3346
			956
			14) 12906 (921
			....
			126
			30
			28
2|0) 92|1 (46			26
..			14
8			
12	*Remains*		(12)
12	*Multiply*		12
01.			24
			12
			14) 144 (10
			..
			14
	Remains		4
	Multiply		4
			qrs.
			14) 16 (1 $\frac{2}{4}$
			14
			Rem. (2)

	l.	*s.*	*d.*	*qrs.*
Facit	46	01	10	1 $\frac{2}{4}$

9. In the Rule of Three it many times happeneth, that although the first and third numbers be Homogeneal (that is, of one kind) as both Money, Weight, Measure, *&c.* yet they may not be of one denomination, or perhaps they may both consist of many denominations, in which case you are to reduce both numbers to one denomination; and likewise your second number (if it consisteth (at any time) of divers denominations) must be reduced to the least name mentioned, or lower if you please, which being done, multiply second and third together, and divide by the first, as is directed in the *7th* Rule of this Chapter.

And note that always the Answer to the Question is in the same denomination that your second number is of, or is reduced to, as was hinted before.

Quest. 5. If 15 Ounces of Silver be worth 3 *l.* 15 *s.* what are 86 Ounces worth at that Rate?

In this Question the numbers being ordered according to the *6th* Rule of this Chapter, the first and third numbers are ounces, and the second number is of divers denominations, *viz.* 3 *l.* 15 *s.* which must be reduced to Shillings, and the shillings multiplyed by the third number, and the product divided by the first, gives you the answer in shillings, *viz.* 430 shillings, which are reduced to 21 *l.* 10 *s.* See the Work.

```
      oz.     l.     s.     oz.
If  15 ——— 3 ——— 15 ——— 86
          20
        ————
          75
          86
        ————
         450
        600
        ————
        2|0)  l.   s.
15) 6450 (43|0  21—10
    60          4
    ——          ——
    45          3
    45          2
    ——          ——
    (0)         (10) shillings
```

In

In reſolving the laſt Queſtion, the Work would have been the ſame, if you had reduced your ſecond number into pence, for then the Anſwer would have been 5160 pence, equal to 21 *l.* 10 *s.* or if you had reduced the ſecond number into farthings, the Quotient or Anſwer would have been 20640 farthings equal to the ſame, as you may prove at your leiſure.

Queſt. 6. If 8 *l.* of Pepper coſt 4 *s.* 8 *d.* what will 7 *C.* 3 *qrs.* 14 *l.* coſt?

In this Queſtion the firſt *number* is 8 *l.* and the third is 7 *C.* 3 *qrs.* 14 *l.* which muſt be reduced to the ſame denomination with the firſt, *viz.* into pounds, and the ſecond *number* muſt be reduced into pence; then multiply and divide according to the 7*th.* Rule foregoing, and you will find the Anſwer to be 6174 pence, which is reduced into 25 *l.* 14 *s.* 6 *d.*

l. s. d. C. qrs. l.

If 8 *coſt* 4—8 *what will* 7—3—14 *coſt?*

12 4
56 31
28
252
63
882
56 *ſecond number*
5292
4410
12) 2|0) l.
8) 49392 (6174 (514 (25
48 60 4
13 17 11
8 12 10
59 54 14 *ſhillings*
56 48
32 (6) *pence*
32
L. s. d.
(0) *Facit* 25—14—6

Queſt. 7. If 3 *C.* 1 *qr.* 14 *l.* of Raiſins coſt 9 *l.* 9 *s.* what will 6 *C.* 3 *qrs.* 20 *l.* of the ſame coſt?

Here the firſt and third numbers each conſiſt of divers denominations, but muſt be brought both into one denomination, *&c.* as you ſee in the Operation which followeth; the Anſwer is 388 *s.* which is reduced into 19 *l.* 8 *s.*

C. qr. l.	l. s.	C. qrs. l.
If 3—1—14 *coſt* 9—9	*what will*	6—3—20 *coſt?*
4	20	4
13	189	27
28		28
108		216
27		56
378 *pounds*		776 *pounds*
		189 *ſecond number*
6984		£ 2|0) l. d.
6208		378) 146664 (38|8 19—8
776		 2
		1134
		18
		3326 18
		3024
		(08) *ſhillings*
		3024
		3024 l. s.
		facit 19—8
		(0)

Queſt. 8. If in 4 *weeks* I ſpend 13 *s.* 4 *d.* how long will 53 *l.* 6 *s.* laſt me at that rate?

Anſwer 2238 *days* equal to 6 *years*, 48 *days.* See the Work.

If 13—4 *require* 4 *what will* 53—06 *cost?*

s.	*d.*	*w.*	*l.*	*s.*
12		7	20	
30		28 *days*	1066	
13			12	
160 *pence*			2132	
			1066	
			12792 *pence*	
			28 *second number*	
			102336	
			25584	
			365)	
16|0)	358	17|6 (2238 (6 *yards*		
		2190		
		32 *Rem.* (48) *days*		
		38		
		32		
		61 *ye. days*		
		48 *fac.* 6—48 $\frac{95}{160}$		
		137		
		128		
		Remains (96)		

Queſt. 9. Suppoſe the yearly Rent of a Houſe, a yearly Penſion, or Wages be 73 *l.* I deſire to know how much it is *per* day?

Here you are to bring the year into days, and ſay, if 365 days require 73 *l.* what will one day require?

Now when you come to multiply 73 by 1, the Product is the ſame, for 1 neither multiplyeth nor divideth, and 73 cannot be divided by 365, becauſe the

Divisor is bigger than the Dividend, wherefore bring the 73 *l.* into shillings, and they make 1460, which divide by the first number 365, and the Quote is 4 shillings for the Answer, as you see in the Work.

days *l.* *day*
If 365 —— 73 —— 1
20

365) 1460 (4 *s.*
1460 *facit* 4 *s. per* Day

(0)

Quest. 10. A Merchant bought 14 pieces of Broad Cloth, each piece containing 28 yards, for which he gave after the Rate of 13 *s.* 6 $\frac{1}{2}$ *d. per* yard, now I desire to know how much he gave for the 14 pieces at that Rate?

First, Find out how many yards are in the 14 pieces, which you will do if you multiply the 14 pieces by 28 (the number of yards in a piece) and it makes 392; then say, If 1 yard cost 13 *s.* 6 $\frac{1}{2}$ *d.* what will 392 yards cost? Work as followeth; and the Answer you will find to be 127400 half-pence, which reduced make 265 *l.* 8 *s.* 4 *d.* For after you have multiplyed your second and third Numbers together, the Product is 127400, which (according to the seventh Rule) should be divided by the first number, but the first number is 1, which neither multiplyeth nor divideth, and therefore the Quotient or fourth number is the same with the Product of the second and third, which is in half-pence, because the second number was so reduced. See the Work, as followeth.

28
14
112
28
392 *yards in the* 14 *pieces*

yard *s.* *d.* *yards*
If 1 *coſt* 13—6½ *what will* 392 *coſt?*
12 325 *the ſecond number*
32 1960
13 784
162 1176
2 2|0 *l.*
24) 127400 (530|8 (265
....
half-pence 325 120 4
74 13
72 12
200 10
l. *s.* *d.* 10
Facit 265—8—4 192
(08) *ſhillings*
Rem. (8) ½ *pence*, or 4 *d.*

Queſt. 11. A Draper bought 420 *yds* of broad-cloth, and gave for it after the rate of 14 *s.* 10 *d.* ¾ *per* Ell *Engliſh*, now I demand how much he paid for the whole at that Rate?

Bring your Ell into quarters, and your given yards into quarters, the Ell is 5 quarters, and in 420 yards are 1680 quarters, then ſay, If 5 quarters coſt 14 *s.* 10 ¾ *d.* (or 715 *farthings*) what will 1680 quarters coſt? *facit* 250 *l.* 05 *s.* 00 *d.* See the Operation.

1 *Ell*

	Ell	*Yards*
	1	420
	5	4
	5 *qrs.*	1680 *qrs.*

qrs.	*s.*	*d.*	*s.*
If 5	14	$10\frac{3}{4}$	1680
	12		715
	28		8400
	15		1680
	178 *d.*		11760
	4	5) 1201200	(24024|0 (250
	715 *qrs.*	10	192
		20	482
Facit	250 — 5 — 09	20	480
		12 *Rem.*	(240) *qrs. or* 5
		10	
		20	
		20	
		(0)	

Queſt. 12. A Draper bought of a Merchant 50 pieces of Kerſeys, each piece containing 34 Ells *Flemiſh*, (the Ell *Flemiſh* being 3 quarters of a yard) to pay after the Rate of 8 *s.* 4 *d. per* Ell *Engliſh*, I demand how much the 50 pieces coſt him at that rate?

Firſt, Find how many Ells *Flemiſh* are in the 50 pieces by multiplying 50 by 34, the Product is 1700, which bring into quarters by 3, it makes 5100 quarters, then proceed, as in the laſt Queſtion, and the Anſwer you will find to be 102000 pence, or 425 *l.* Behold the Operation, as followeth.

If

qrs.	*s.*	*d.*		*qrs.*			
If 5	8	4		5100			50
	12			100			34
					d.		
110*d.*			5)	510000	(102000		200
				.....			150
				5			
							1700 *Ells Flem.*
				10			3
				10			
							5100 *quarters*

	(0)	2|0)	*l.*	
12)	102000	(850|0	(425	
	..	..		
	96	8		
	60	5		
	60	4		
	(0)	10		
		10		
Facit 425 *pound*		(0)		

Queſt. 13. A Goldſmith bought a Wedge of Gold which weighed 14 *l.* 3 *oz.* 8 *p.w.* for the Sum of 514 *l.* 4 *s.* I demand what it ſtood him in *per* Ounce? Anſwer 60 ſhillings, or 3 *l.* See the work.

l.	*oz.*	*p.w.*		*l.*	*s.*	*oz.*
If 14	3	8		514	4	1
12				20 *ſhillings*		20
31				10284 *ſhillings*		20 *p.w.*
14				20 *p.w.*		
171 *oz.*				2|0)		
20			3428)	205680	(6|0	(3 *l.*
				..	6	
3428 *p.w.*				20568		*s.* *l.*
				(0) *facit*	60 *or*	3

Queſt. 14. A Grocer bought 4 *hhds* of Sugar, each weighing near 6 *C.* 2 *qrs.* 14 *l.* which coſt him 2 *l.* 8 *s.* 6 *d.* *per C.* I demand the value of the 4 *hhds* at that rate?

Firſt, Find the weight of the 4 *hhds*, which you may do by reducing the weight of one of them into pounds and multiply them by 4 (the Number of *hhds*) and they make 2968 *l.* then ſay, If 1 *C.* or 112 *l.* coſt 2 *l.* 8 *s.* 6 *d.* what will 2968 *l.* coſt? *Facit* 64 *l.* 5 *s.* 3 *d.* As by the Operation.

C. *qrs.* *l.*
6——2——14
4
26
28
212
53
472 *l. in* 1 *hhd.*
4 *hogſheads*
2968 *l. in* 4 *hhds*

l. *l.* *s.* *d.* *l.*
If 112—2—8—06— 2968
20 582
48 5936
12 23744
14840
102 12)
48 112) 1727376 (15423
582 112
607
560
473
448
257
224
336
336
(0)

2|0) *l.*
128|5 (64
12
8
8
(05) *ſhillings*
96
63
60
(3) *pence*

l. *s.* *d.*
Facit 64——5——3

Queſt.

Queſt. 15. A Draper bought of a Merchant 8 packs of Cloth, each pack containing 4 parcels, and each parcel 10 pieces, and in each piece 26 yards, and gave after the Rate of 4 *l.* 16 *s.* for 6 yards, now I deſire to know how much he gave for the whole? *Anſwer* 6656 *l.*

Firſt, Find out how many yards there were in the 8 packs, as by the following work you will find there are 8320 yards; then ſay if 6 yards coſt 4 *l.* 16 *s.* what will 8320 yards coſt, *&c.*

8 *packs*
4
32 *parcels*
10
320 *pieces*
26
1920
640
8320 *yds*

yds. *l.* *s.* *yds.*
If 6—4—16—8320
20 96
96 49920
74880
2|0) *l.*
6) 798720 (133911|0 (6656
6 12
19 13
18 12
18 11
18 10
07 12
6 12
12 (0)
12
(0)

Facit 6656 *l.*

By this time the Learner is (I ſuppoſe) well exerciſed in the Practick and Theorick of the Rule of Three Direct, but at his leiſure he may look over the following Queſtions, whoſe Anſwers are given, but the operation purpoſely omitted as a Touchſtone for the Learner, thereby to try his Ability in what hath been delivered in the former Rules.

Queſt. 16. If 24 *l.* of Raiſins coſt 6 *s.* 6 *d.* what will 18 Frails coſt, each weighing Neat 3 *qrs.* 18 *l.* *Anſwer* 24 *l.* 17 *s.* 03 *d.*

Queſt. 17. If an Ounce of Silver be worth 5 ſhillings, what is the price of 14 Ingots, each Ingot weighing 7 *l.* 5 *oz.* 10 *p.w.*? *Anſwer* 313 *l.* 5 *s.*

Queſt. 18. If a piece of Cloth coſt 10 *l.* 16 *s.* 8 *d.* I demand how many Ells *Engliſh* there are in the ſame, when the Ell at that rate is worth 8 *s.* 4 *d.*? *Anſw.* 26 Ells *Engliſh.*

Queſt. 19. A Factor bought 84 pieces of Stuffs, which coſt him in all 537 *l.* 12 *s.* at 5 *s.* 4 *d.* *per* yar. I demand how many Yards there were in all, and how many Ells *Engliſh* were contained in a piece of the ſame? *Anſwer* 2016 Yards in all, and 19 $\frac{1}{5}$ Ells *Engliſh per* piece.

Queſt. 20. A Draper bought 242 yards of Broadcloth, which coſt him in all 254 *l.* 10 *s.* for 86 yards, of which he gave after the Rate of 21 *s.* 4 *d.* *per* yard, I demand how many he gave *per* yard for the Remainder? *Anſw.* 20 *s.* 10 *d.* $\frac{64}{156}$ *per* yards.

Queſt. 21. A Factor bought a certain quantity of Serge and Shalloon, which together coſt him 26 *l.* 14 *s.* 10 *d.* the quantity of Serge he bought was 48 yards at 3 *s.* 4 *d.* *per* yard, and for every two yards of Serge he had 5 yards of Shalloon, I demand how many yards of Shalloon he had, and how much the Shalloon coſt him *per* yard? *Anſw.* 120 yards of Shalloon at 1 *l.* 16 *s.* 05 $\frac{5}{12}$ $\frac{8}{10}$ *d.* *per* yard.

Queſt. 22. An Oyl-man bought 3 Tun of Oyl, which coſt him 151 *l.* 34 *s.* and it ſo chanced that it leaked out 85 gallons, but he is minded to ſell it again, ſo as that he may be no loſer by it, I demand how he

must

must sell it *per* gallon? *Answer*, at 4 *s.* 6 $\frac{174}{871}$ *d. per gallon.*

Quest. 23. Bought 6 packs of Cloth, each pack containing 12 Cloths, which at 8 *s.* 4 *d. per Ell Flemish* cost 1080 *l.* I demand how many yards there were in each Cloth? *Answer* 27 yards in each Cloth.

Quest. 24. A Gentleman hath 536 *l. per annum*, and his Expences are one day with another 18 *s.* 10 *d.* 3 *qrs.* I desire to know how much he layeth up at the years end? *Answer* 191 *l.* 3 *s.* 0 *d.* 1 *qr.*

Quest. 25. A Gentleman expendeth daily one day with another 27 *s.* 10 $\frac{1}{2}$ *d.* and at the years end layeth up 340 *l.* I demand how much is his yearly Income? *Answer* 848 *l.* 14 *s.* 4 *d.* $\frac{1}{2}$.

Quest. 26. If I sell 14 yards for 10 *l.* 10 *s.* 00 *d.* how many Ells *Flemish* shall I sell for 283 *l.* 17 *s.* 6 *d.* at that rate? *Answer* 504$\frac{2}{3}$ Ells *Flemish.*

Quest. 27. If 100 *l.* in 12 Months gain 6 *l.* Interest, how much will 75 *l.* gain in the same time, and at the same rate? *Answer* 4 *l.* 10 *s.*

Quest. 28. If 100 *l.* in 12 Months gain 6 *l.* Interest, how much will it gain in 7 Months at that rate? *Answer* 3 *l.* 10 *s.*

Quest. 29. A certain Usurer put out 75 *l.* for 12 Months, and received Principal and Interest 81 *l.* I demand what rate *per Cent.* he received Interest? *Answer* 8 *l. per Cent.*

Quest. 30. A Grocer bought 2 Chests of Sugar, the one weighed neat 17 *C.* 3 *qrs.* 14 *l.* at 2 *l.* 6 *s.* 8 *d. per C.* the other weighed neat 18 *C.* 1 *qr.* 21 *l.* at 4 $\frac{1}{2}$ *d. per l.* which he mingleth together, now I desire to know how much a *C. weight* of this mixture is worth? *Answer* 2 *l.* 4 *s.* 3 *d.* 2 $\frac{556}{4087}$ *qrs.*

Quest. 31. Two men, *viz. A* and *B* departed both from one place, the one goes East, and the other West, the one travelleth 4 miles a day, the other 5 miles a day, how far are they distant the 9*th* day after their departure? *Answer* 91 *miles.*

Quest.

Queſt. 32. *A* flying every day 40 miles is purſued the 4*th* day after by *B*, poſting 50 miles a day, now the Queſtion is in how many days, and after how many miles Travel will *A* be overtaken? *Anſwer*, *B* overtakes him in 32 days, when they have travelled 600 miles.

Moore's Arithm. Chap. 8. Queſt. 7.

11. The general Effect of the Rule of Three Direct, is contained in the definition of the ſame, that is, to find a fourth Number in proportion conſiſting of two equal Reaſons, as hath been fully ſhewn in all the foregoing Examples.

The ſecond Effect is, by the price or value of one thing to find the price or value of many things of like kind.

The third Effect is, by the price or value of many things to find the price of one, or by the price of many things (the ſaid price being 1) to find the price of many things of like kind.

The fourth Effect is, by the price or value of many things, to find the price or value of many things of like kind.

The fifth Effect is, thereby to reduce any Number of Moneys, Weight, or Meaſure, the one ſort into the other, as in the Rules of Reduction contained in the Eighth Chapter foregoing. Examples of its various Effects have been already anſwered.

12. The Rule of 3 Direct is thus proved, *viz.* multiply the firſt Number by the fourth, and note the Product, then multiply the ſecond number by the third, and if this Product is equal to the Product of the firſt and fourth, then the work is rightly performed, otherwiſe it is erroneous.

The Proof of the Rule of Three Direct.

So the firſt Queſtion of this Chapter (whoſe Anſwer, or fourth number we found to be 18 *s.*) is thus proved, *viz.* the firſt number is 4, which multiplied by 18 (the fourth) produceth 72. And the ſecond and third numbers are 12 and 6, which multiplied together produce 72, equal to the Product of the firſt and fourth, and therefore I conclude the work to be right-

Always observing, that if any thing remain after you have divided the Product of the second and third numbers, by the first, such remainder in proving the same, must be added to the Product of the first and fourth *Numbers*, whose Sum will be equal to the Product of the second and third, (the second *number* being of the same denomination with the fourth, and the first with the same denomination of the third.)

So the Fourth Question of this Chapter being again repeated, *viz.* If 14 *l.* of Tobacco cost 27 *s.* what will 478 *l.* cost at that Rate? The Answer (or fourth *number*) was 46 *l.* 01 *s.* 10 *d.* 1 *qr.* $\frac{2}{14}$, which is thus proved, *viz.* bring the fourth *number* into *farthings*, and it makes 44249, which multiplied by the first *number* 14, produceth 619488 (the second which remaineth being added thereto) then (because I reduce my fourth *number* into *farthings*) I reduce my second (*viz.* 27 *s.*) into *farthings*, and they are 1296, which multiplyed by the third *number* 478, their Product is 619488 equal to the Product of the *first* and *fourth Numbers*. Wherefore I conclude the Operation to be true. This is an infallible way to prove the Rule of Three *Direct*, and it is deduced from the 12*th Section* of the 9*th Chapter* of this Book.

Thus much concerning the single Rule of Three *Direct*, and I question not but by this time the Learner is sufficiently qualified to resolve any question pertinent to this Rule, not relying upon *Fractions*, or *Geometrical Magnitudes*. Those that are desirous to see the Demonstration of this Rule, let them read the *sixth Chapter* of (the ingenious) Mr. *Kersey's* Appendix to *Wingates* Arithmetick. Or the *sixth Chapter* of Mr. *Oughtreds* (Incomparable) *Clavis Mathematicæ*: By both which Authors this Rule is largely demonstrated, being grounded upon the 19*th Prop.* of the 7*th*, and the 19*th Prop.* of the 9*th* of *Euclid. Elem.*

CHAP.

CHAP. XI.

The Single Rule of Three Inverſe.

1. THE Golden Rule, or Rule of 3 Inverſe, is when there are 3 *Numbers* given to find a fourth, in ſuch proportion to the 3 given Numbers, ſo as the fourth proceeds from the ſecond, according to the ſame Rate, Reaſon, or Proportion that the firſt proceeds from the third, or the Proportion is,

As the third *number* is in proportion to the ſecond, ſo is the firſt to the fourth. *Alſted. Matth. lib. 2. cap. 14.*

So if the 3 *numbers* given were 8, 12, and 16, and it were required to find a fourth *number* in an inverted proportion to theſe, I ſay that as 16 (the third *Number*) is the double of the firſt *term* or *number* (8) ſo muſt 12 (the ſecond *number*) be the double of the fourth; ſo will you find the fourth *term* or *number* to be 6. And as in the Rule of 3 *Direct*, you multiply the ſecond and third together, and divide their Product for a fourth *Proportional Number*: So,

2. In the Rule of 3 *Inverſe*, you muſt multiply the ſecond *term* by the firſt (or firſt *term* by the ſecond) and divide the Product thereof by the third *term*, ſo the quotient will give you the fourth *term* ſought in an Inverted *Proportion*. The ſame order being obſerved in this Rule, as in the Rule of 3 *Direct*, for placing and diſpoſing of the given *numbers*, and after your *numbers* are placed in order, that you may know whether your Queſtion be to be reſolved by the Rule *Direct* or *Inverſe*, obſerve the general Rule following.

3. When your Queſtion is ſtated, and your *numbers* orderly diſpoſed, Conſider in the firſt place whether the fourth *term* or *number* ſought, ought to be more or leſs than the ſecond *term*; which you may eaſily do: And if it is required to be more, or greater than the ſecond *term*, then the leſſer *Extream* muſt be your Diviſor; but if it require leſs, then the biggeſt *Ex-*

tream must be your Divisor, (in this Case the first and third *numbers* are called *Extreams* in respect of the second,) and having found out your Divisor, you may know whether your Question belong to the Rule *Direct* or *Inverse*; for if the third *term* be your Divisor, then it is *Inverse*, but if the first *term* be your Divisor, then it is a *Direct* Rule. As in the following Questions.

Quest. 1. If 8 Labourers can do a certain piece of work in 12 days, in how many days will 16 Labourers do the same? *Answer* in 6 days.

Having placed the *numbers* according to the *6th* Rule of the *10th* Chapter, I consider that if 8 Men can finish the Work in 12 days, 16 Men will do it in lesser (or fewer dayes, than 12,) therefore the biggest *Extream* must be the Divisor, which is 16, and therefore it is the Rule of 3 *Inverse*, wherefore I multiply the first and second *numbers* together, *viz.* 8 by 12, and their *Product* is 96, which divided by 16, Quotes 6 days for the *Answer*, and in so many days will 16 Labourers perform a piece of work, when 8 can do it in 12 days.

lab.	*days*	*lab.*
8	12	16

8

16) 96 (6 *days*
96

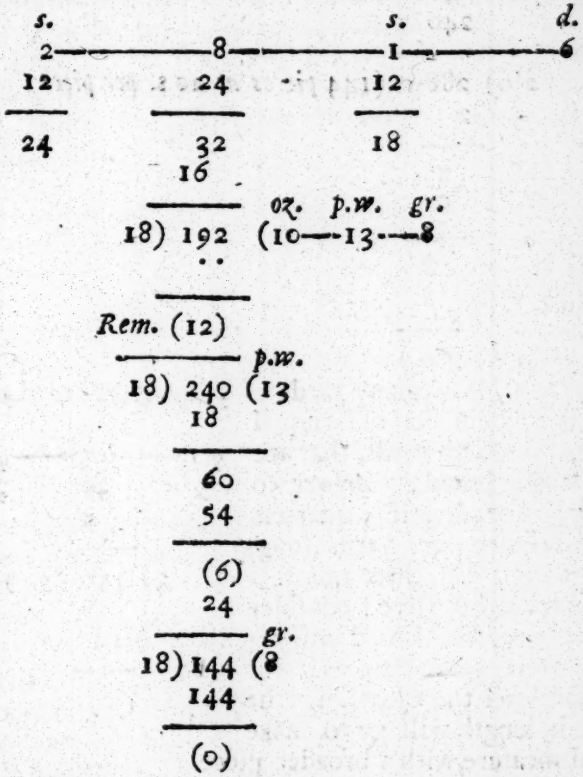
(0)

Facit 6 *days*

Quest. 2. If when the measure (*viz.* a peck) of Wheat cost 2 shillings, the penny Loaf weighed (according to the Standard, Statute, or Law of *England*) 8 Ounces, I demand how much it will weigh when the peck is worth 1 *s.* 6 *d.* according to the same Rate or Proportion? *Answer* 10 *oz.* 13 *p.w.* 8 *gr.*

Having placed and reduced the given *numbers* according to the 6 and 9 Rules of the *10th* Chapter, I consider, that at 1 *s.* 6 *d.* *per* peck, the penny Loaf will weigh more than at 2 *s.* *per* peck, for as the price decreaseth, the weight increaseth, and as the price increaseth, so the weight diminisheth, wherefore because the *term* requireth more than the second, the lesser *Extream* must be the Divisor, 1 *s.* 6 *d.* or 18 *d.* and having finished the work, I find the *Answer* to be 10 *oz.*

13 *p.w.* 8 *gr.* and so much will the peuny Loaf weigh, when the peck of Wheat is worth 1 *s.* 6 *d.* according to the given rate of 8 ounces, when the peck is worth 2 shillings, the work is plain in the following operation.



Queſt. 3. How many pieces of Money or Merchandiſe at 20 *s. per* piece are to be given or received for 240 pieces, the value or price of every piece being 12 ſhillings? *Anſwer*, 144. For if 12 *s.* require 240 pieces, then 20 ſhillings will require leſs; therefore the biggeſt *Extream* muſt be the Diviſor, which is the third number, *&c.* See the Work.

s. pieces s.
If 12—240—20
12
480
240
2|0) 288|0 (144 *pieces at* 20 *s. per piece*
2
8
8
8
8
(0)

Queſt. 4. How many yards of 3 quarters broad are required to double, or be equal in meaſure to 30 yards, that are 5 quarters broad? *Anſwer* 50 yards, For ſay, if 5 quarters wide require 30 yards long, what length will three quarters broad require? Here I conſider that 3 quarters broad will require more yards than 30, for the narrower the Cloath is, the more in length will go to make equal meaſure with a broader piece.

qrs.	*long*	*qrs*
5	30	3
	5	
	3) 150 (50 *yds*	
	15	
	(0)	

Queſt. 5. At the Requeſt of a Friend I lent him 200 *l.* for 12 Moneths, promiſing to do me the like Courteſie at my Neceſſity; but when I came to requeſt it of him, he could let me have but 150 *l.* now I deſire to know how long I may keep this Money to make plenary ſatisfaction for my former kindneſs to my Friend? *Anſwer* 16 Months. I ſay, if 200 *l.* require 12 Months, what will 150 *l.* require? 150 *l* will require more time than 12 Months, therefore the leſſer *Extream* (*viz.* 150) muſt be the Diviſor, Multi-

ply and divide, and you will find the fourth inverted *Proportional* to be 16, and so many Months I ought to keep the 150 *l.* for satisfaction.

Quest. 6. If for 24 *s.* I have 1200 *l.* weight carried 36 miles how many miles shall 1800 *l.* be carried for the same Money? *Answer* 24 miles.

Quest. 7. If for 24 *s.* I have 1200 *l.* carried 36 miles, how many pound weight shall I have carried 24 miles for the same Money? *Answer* 1800 *l.* weight.

Quest. 8. If 100 Workmen in 12 days finish a piece of work or service, how many Workmen are sufficient to do the same in 3 days? *Answer* 400 Workmen.

Quest. 9. A Colonel is besieged in a Town in which are 1000 Soldiers, with provision of Victuals only for 3 Moneths, the Question is, how many of his Soldiers must he dismiss, that his Victuals may last the remaining Soldiers 6 months? *Answer*, 500 he must keep, and dismiss as many.

Quest. 10. If Wine worth 20 *l.* is sufficient for the Ordinary of 100 Men, when the Tun is sold for 30 *l.* how many Men will the same 20 pounds worth suffice, when the Tun is worth 24 *l.* *Answer*, 125 Men.

Quest. 11. How much Plush is sufficient to line a Cloak which hath in it 4 yards of 7 quarters wide, when the Plush is but 3 quarters wide? *Answer*, $9\frac{1}{3}$ yards of Plush.

Quest. 12. How many yards of Canvas that is Ell wide, will be sufficient to line 20 yards of Say, that is 3 quarters wide? *Answer*, 12 yards.

Quest. 13. How many yards of Matting that is two foot wide, will cover a Floor that is 24 Foot long, and 20 Foot broad? *Answer*, 240 Foot.

Quest. 14. A Regiment of Soldiers consisting of 1000, are to have new Coats, and each Coat to contain 2 yards, 2 quarters of Cloth, that is 5 quarters wide, and they are to be lined with Shalloon that is 3 quarters wide, I demand how many yards of Shalloon will line them? *Answer*, $16666\frac{2}{3}$ quarters of yards, or $4166\frac{3}{4}$ yards.

Quest.

Queſt. 15. A Meſſenger makes a Journey in 24 days, when the day is 12 hours long, I deſire to know in how many days he will go the ſame when the day is 16 hours long? *Anſwer*, in 18 days.

Queſt. 16. Borrowed of my Friend 64 *l.* for 8 Months, and he hath occaſion another time for to borrow of me for 12 Months, I deſire to know how much I muſt lend to make good his former kindneſs to me? *Anſwer*, 42 *l.* 13 *s.* 04 *d.*

4. The general Effect of the Rule of 3 *Inverſe* is contained in the definition of the ſame, that is, to find a fourth *term* in a Reciprocal Proportion, inverted to the Proportion given.

The ſecond Effect, is by two prices, or values of two ſeveral pieces of Money or Merchandize known, to find how many pieces of the one price is to be given for ſo many of the other. And conſequently to Reduce and Exchange one ſort of Money, or Merchandize, into another. Or contrariwiſe to find the price unknown of any piece given to Exchange in Reciprocal Proportion.

The third Effect, is, by two differing prices of a meaſure of Wheat bought or ſold, and the weight of the Loaf of Bread, made anſwerable to one of the prices of the meaſure given, to find out the weight of the ſame Loaf, anſwerable to the other price of the ſaid meaſure given. Or contrariwiſe by the two ſeveral Weights of the ſame prized Loaf, and the price of the meaſure of Wheat anſwerable to one of thoſe Weights given, to find out the other price of the meaſure anſwerable to the other weight of the ſame Loaf.

The fourth Effect, is, by two lengths, and one breadth of two Rectangular Planes known, to find out another breadth unknown. Or by two breadths and one length given, to find out another length unknown in an inverted Proportion.

The fifth Effect, is, by double time and a capital Sum of Money borrowed or Lent, to find out another capital Sum anſwerable to one of the given Times;

or otherwiſe, by two Capital Sums, and a time anſwerable to one of them given to find out a time anſwerable to the other Capital Sum in Reciprocal Reaſon.

The ſixth Effect is, by two differing Weights of Carriage, and the diſtance of the places in Miles or in Leagues given, to find another diſtance in miles anſwerable to the ſame price of payment: Or otherwiſe by two diſtances in miles, and the weight anſwerable to one of the diſtances (being carried for a certain price) to find out the weight anſwerable to the other diſtance for the ſame price.

The ſeventh Effect is by double Workmen, and the time anſwerable to one of the *numbers* of Workmen given, to find out the time anſwerable to the other *number* of Workmen, in the performance of any work or ſervice. Or contrariwiſe, by double time and the Workmen anſwerable to one of thoſe times given, to find out the *number* of Workmen anſwerable to the other time, in the performance of any work or ſervice.

Alſo by a double price of Proviſion, and the *number* of Men, or other Creatures nouriſhed for a certain time, anſwerable to one of the prices of Proviſion given, to find out another Number of Men or other Creatures anſwerable to the other price of the Proviſion for the ſame time. Or contrariwiſe by two *numbers* of Men or other Creatures nouriſhed, and one price of Proviſion anſwerable to one of the *numbers* of Creatures given, to find out the other price of the ſame Proviſion anſwerable to the other *number* of Creatures, both being ſuppoſed to be nouriſhed for the ſame, *&c.* As in the foregoing Examples is fully declared.

To prove the Operation of the Rule of 3 *Inverſe*, multiply the third and fourth *terms* together, and note their Product; and multiply the firſt and ſecond together, and if their Product is equal to the Product of third and fourth, then is the Work truely wrought, but if it falleth out otherwiſe, then it is erroneous.

As in the firſt Queſtion of this Chapter, 16 (the third *number*) being multiplied by 6 (the fourth *number*)

the Product is 56, and the Product of 8 (the first number) multiplyed by 12 (the second number) is 96, equal to the first Product, which proves the work to be Right.

And Note, that if in Division any thing remain, such Remainder must be added to the Product of the third and fourth terms, and if the Sum be equal to the Product of the first and second (the homogeneal terms being of one denomination) the work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the Rules of *Single Proportion*, and we come now to lay down the Rules of *Plural Proportion*.

1. *Plural Proportion*, is when more Operations in the Rule of Three than one, are required before a Solution can be given to the Question propounded. Therefore in Questions that require Plurality in *Proportion*, there are always given more than three *numbers*.

2. When there are given 5 *numbers*, and a sixth is required in *Proportion* thereunto, then this sixth *Proportion* is said to be found out by the double Rule of 3, as in the Question following, *viz.*

If 100 *l.* in 12 months gain 6 *l.* Interest, how much will 75 *l.* gain in 9 months?

3. Questions in the double Rule of 3 may be resolved either by two single Rules of Three, or by one single Rule of Three, compounded of the five given *Numbers*.

4. The double Rule of 3 is either *Direct*, or else *Inverse*.

5. The double Rule of 3 *Direct*, is when unto 5 given *Numbers* a sixth *proportional* may be found out by two single Rules of Three *Direct*.

6. The five given *Numbers* in the double Rule of

Three, consist of 2 parts, *viz.* First, a Supposition, and Secondly, of a Demand; the Supposition is contained in the *three first* of the *five* given *Numbers*, and the Demand lies in the two last; as in the Example of the second Rule of this Chapter, *viz.* If 100 *l.* in 12 months gain 6 *l.* Interest, what will 75 *l.* gain in 9 months? Here the Supposition is expressed in 100, 12, and 6; for it is said, if (or suppose) 100 *l.* in 12 months gain 6 *l.* Interest, and the Demand lyeth in 75 and 9; for it is demanded how much 75 *l.* will gain in 9 months?

7. When your Question is stated, the next thing will be to dispose of the given Numbers in due order and place, as a Preparative for Resolution; which that you may do, First, observe which of the given Numbers in the Supposition is of the same Denomination with the Number required; for that must be the second number (in the first operation) of the single Rule of 3, and one of the other Numbers in the Supposition (it matters not which) must be the first Number, and that Number in the Demand which is of the same Denomination with the first, must be the third number, which three Numbers being thus placed, will make one perfect Question in the single Rule of Three, as in the forementioned Example: First, I consider that the *Number* required in the Question is the Interest or Gain of 75 *l.* therefore that *Number* in the Supposition which hath the same name (*viz.* 6 *l.* which is the Interest or Gain of 100 *l.*) must be the second *Number* in the first Operation, and either 100 or 12 (it matters not which) must be the first *Number*; but I will take 100, and then for the third *Number*, I put that *Number* in the Demand which hath the same Denomination with 100, which is 75, (for they both signifie pounds principal) and then the *Numbers* will stand as you see in the Margent.

100—6—75

But if I had for the first *Number* put the other *Number* in the Supposition, *viz.* 12, which signifieth 12 Months, then the third *number* must have been 9, which is that *Number* in the Demand which hath the same Denomination with the first, *viz.* 9 Months, and then they will stand as you see in the Margent.

10	6	9

There yet remain two *Numbers* to be disposed of and those are, one in the Supposition, and another in the Demand; that which is of the Supposition, I place under the first of the three *Numbers*, and the other which is in the Demand I place under the third *number*, and then 2 of the *terms* in the supposition will stand (one over the other) in the first place, and the 2 *terms* in the Demand will stand (one over the other) in the third place, as in the Margent.

100	6	75
12		9

Or thus,

12	6	9
100		75

8. Having disposed, or ordered the *numbers* given according to the last Rule, we may proceed to a Resolution, and first I work with the three uppermost *Numbers*, which according to the first disposition are 100, 6, and 75, which is as much as to say, If 100 *l.* require 6 *l.* (Interest) how much will 75 *l.* require? which by the the third Rule of the eleventh Chapter I find to be *Direct*, and by the 7 and 8 Rules of the tenth Chap. I find the fourth *Proportional number* to be 4 *l.* 10 *s.* so that by the foregoing single Question I have discovered how much Interest 75 *l.* will gain in 12 mon.; the operation whereof followeth on the left hand under the letter *A*; and having discovered how much 75 *l.* will gain in 12 Months, we may by another Question easily discover how much it will gain in 9 months, for this fourth *number* (thus found) I put in the middle between the two lowest *Numbers* of the five after they are placed according to the seventh Rule of this Chapter; and then it will be a second *Number*, in another Question in the Rule of Three, the *numbers* being

m.	l.	s.	m.
12	4	10	9

the first and third

numbers being of one Denomination, *viz.* both Months, and may be thus expreſſed, if 12 months require 4 *l.* 10 *s.* Intereſt, what will 9 months require? And by the third Rule of the 11*th* Chapter I find it to be the *Direct* Rule, and by working according to the directions laid down in the 7, 8, and 9 Rules of the 10*th* Chapter, I find the fourth *Proportional number* to the laſt ſingle Queſtion to be 3 *l.* 07 *s.* 06 *d.* which is the ſixth *Proportional number* to the 5 given *numbers*, and is the Anſwer to the general Queſtion. The work of the laſt ſingle Queſtion is expreſſed on the Right ſide of the Page under the Letter *B*, as followeth,

100——6——75

A 12 9 B

l.	l.	l.
If 100	6	75

75

30
42

l. s.

1|00) 4|50 (4--10
4

Rem. (50)
Mult. 20

1|00)10|00 (10 *s.*

l.	*s.*
Facit 4	10

Then ſay,

m.	*l.*	*s.*	*m.*
If 12	4	10	9

20

90 *ſhillings*
12

180
90

1080 *pence*

12) 2|0)l. s. d.
9

12) 9720 (810 (6|7 (3--7--6
96 72

12 90
12 84

(0) (6) *pence*

l.	*s.*	*d.*
Facit 3	7	6

So that by the foregoing Operation I conclude that if 100 *l.* in 12 months gain 6 *l.* Interest, 75 *l.* will gain 3 *l.* 7 *s.* 6 *d.* in 9 months, after the same rate.

The Answer would have been the same, if the 5 given *Numbers* had been ordered according to the second Method, *viz.* as you see in the Margent.

12	6	9
100		75

For first, I say, if 12 months gain 6 *l.* what will 9 months gain? This Question I find to be *Direct* by the 3*d* Rule of the 11*th* Chapter, and by the 7 and 8 Rules of the 10*th* Chapter, I find the fourth *Proportional Number* to these three to be 4 *l.* 10 *s.*

Thus have I found out what is the Interest of 100 *l.* for 9 months, and I am now to find the Interest of 75 *l.* for 9 months; to effect which, I make this 4*th Number* (found as before) to be my second *Number* in the next Question, and say, If 100 *l.* require 4 *l.* what will 75 require? This Question I find (by the said third Rule of the eleventh Chapter) to be *Direct*, and by the said 7*th*, 8*th*, and 9*th* Rules of the tenth Chapter, I find the Answer to be as before, *viz.* 3 *l.* 7 *s.* 6 *d.*

This Rule hath been sufficiently explained by the foregoing Example, so that the Learner may be able to resolve the following (or any other) Questions pertinent to the double Rule of 3 *Direct*, whose Answers are there given, but the Operation purposely omitted to try the Learners ability in the knowledge of what hath been before delivered.

Quest. 2. A second Example in this Rule may be as followeth, *viz.* a Carrier receiveth 42 shillings for the Carriage of 300 weight 150 Miles, I demand how much he ought to receive for the Carriage of 7 *C.* 3 *qrs.* 14 *l.* 50 miles at that rate? *Answer*, 36 *s.* 9 *d.*

Quest. 3. A Regiment of 936 Soldiers eat up 351 quarters of Wheat in 168 Days, I demand how many quarters of Wheat 11232 Soldiers will eat in 56 Days at that rate? *Answer*, 1404 *qrs.*

Quest. 4. If 40 Acres of Grass be mowed by 8 men in 7 Days, how many Acres shall be mowed by 24 men in 28 days? *Answer*, 480 Acres.

Quest.

Queſt. 5. If 48 Buſhels of Corn (or other ſeed) yield 576 Buſhels in 1 Year, how much will 240 Buſhels yield in 6 years at that rate? That is to ſay, if there were ſowed 240 Buſhels every one of the 6 years? *Anſwer*, 17280 Buſhels.

Queſt. 6. If 40 ſhillings is the Wages of 8 Men for 5 days, what ſhall be the Wages of 32 men for 24 days? *Anſwer*, 768 ſhillings, or 38 *l.* 8 *s.*

Queſt. 7. If 14 Horſes eat 56 Buſhels of Provender in 16 Days, how many Buſhels will 20 Horſes eat in 24 Days? *Anſwer*, 120 Buſhels.

Queſt. 8. If 8 Cannons in 1 Day ſpend 48 Barrels of Powder, I demand how many Barrels 24 Cannons will ſpend in 22 days at that rate? *Anſwer*, 1728 Barrels.

Queſt. 9. If in a Family conſiſting of 7 Perſons there are drunk out 2 Kilderkins of Beer in 12 days, how many Kilderkins will there be drunk out in 8 days by another Family conſiſting of 14 Perſons? *Anſwer*, 48 Gallons, or 2 Kilderkins and 12 Gallons.

Queſt. 10. An *Uſurer* put 75 *l.* out to receive Intereſt for the ſame, and when it had continued 9 Months, he received for Principal and Intereſt 78 *l.* 7 *s.* 6 *d.* I demand at what rate *per Cent. per Annum*, he received Intereſt? *Anſwer*, at 6 *l. per Cent. per Annum.*

CHAP. XIII.

The Double Rule of Three Inverſe.

1. THE Double Rule of 3 *Inverſe*, is, when a Queſtion in the Double Rule of 3 is reſolved by 2 Single Rules of 3, and one of thoſe Single Rules falls out to be *Inverſe*, or requires a fourth *number* in *Proportion Reciprocal* (for both the Queſtions are never *Inverſe*.)

2. In all Queſtions of the Double Rule of 3 (as well *Inverſe* as *Direct*,) you are (in the diſpoſing of the 5 given

numbers) to obſerve the ſeventh Rule of the 12*th* Chapter, and in reſolving of it by two ſingle Rules, obſerve to make Choice of your *Numbers* for the firſt, and ſecond, ſingle Queſtions according to the directions given in the eighth Rule of the ſame Chapter, as in the Example following, *viz.*

Queſt. 1. If 100 *l.* Principal in 12 Months gain 6 *l.* Intereſt, what Principal will gain 3 *l.* 7 *s.* 6 *d.* in 9 months?

This Queſtion is an Inverſion of the firſt Queſtion of the 12*th* Chapter, and may ſerve for a proof thereof.

In order to a Reſolution, I diſpoſe of the 5 given *Numbers* according to the 7*th* Rule of the laſt Chapter, and being ſo diſpoſed, will ſtand as followeth,

12 ——— 100 ——— 9
6 l. s. d.
3—7—6

Or thus,

l. s. d.
6 ——— 100 ——— 3—7—6
12 9

Here obſerve, that according to the eighth Rule of the twelfth Chapter, the firſt Queſtion, if you take it from the 5 *Numbers*, (as they are ordered or placed firſt) will be, If 12 months require 100 *l.* Principal what will 9 months require to make the ſame Intereſt? This (according to the third Rule of the 11 Chapter) is *Inverſe*, and the Anſwer will be found (by the 2 Rule of the 11*th* Chapter) to be 133 *l.* 6 *s.* 8 *d.* the ſecond queſtion then will be, If 6 *l.* Intereſt, require 133 *l.* 6 *s.* 8 *d.* Principal, how much Principal will 3 *l.* 7 *s.* 6 *d.* require? This is a direct Rule, and the Anſwer in a direct *Proportion* is 75 *l.* See the Work.

First I say,

m.	l.	m.
If 12	100	9

12

	l.	s.	d.
9) 1200	(133	6	8

9.

	l.	s.	d.
facit	133	6	8

30
27

30
27

(3)
20

9) 60 (6 *s.*
54

(6)
72

9) 72 (8 *d.*
72

(0)

Then

Then I say,

l.	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
If 6	133	6	8	3	7	6
240	20		20			
1440 *d.*	2666		67			
	12		12			
	5340		140			
	2666		67			
	32000		810 *d.*			
	810					
	320000					
	256					

144|0) 2592000|0 (18000 *d.* or 75 *l.*

144

1152

1152

So that by the foregoing Work I find that if 6 *l.* Interest be gained by 100 *l.* in 12 months, 3 *l.* 7 *s.* 6 *d.* will be gained by 75 *l.* in 9 months.

But if the resolution had been found out by the Numbers as they are ranked in the second place, then the second Question in the single Rule would have been *Inverse*, and the first Question *Direct*, and the conclusion the same with the first Method, *viz.* 75 *l.*

Quest. 2. If a Regiment consisting of 936 Soldiers, can eat up 351 quarters of Wheat in 168 days, how many Soldiers will eat up 1404 quarters in 56 days at that rate? *Answer*, 11232 Soldiers.

Quest. 3. If 12 Students in 8 Weeks spend 48 *l.* I demand how many Students will spend 288 *l.* in 18

Queſt. 4. If 48 *l.* ſerve 12 Students 8 Weeks, how many weeks will 288 *l.* ſerve 4 Students? *Anſwer* 144 Weeks.

Queſt. 5. If when the Buſhel of Wheat coſt 3 *s.* 4 *d.* the peny Loaf weigheth 12 ounces, I demand the weight of the Loaf worth 9 *d.* when the Buſhel coſt 10 *s.* *Anſwer* 36 *ounces.*

Queſt. 6. If 48 Pioneers in 12 days caſt a Trench 24 *yards* long, how many Pioneers will caſt a Trench 168 *yards* long in 16 days? *Anſwer* 252 Pioneers.

Queſt. 7. If 12 *C.* weight being carried 100 mile coſt 5 *l.* 12 *s.* I deſire to know how many *C.* weight may be carried 150 miles for 12 *l.* 2 *s.* at that rate? *Anſwer*, 18 *C.*

Queſt. 8. If when Wine is worth 30 *l. per Tun*, 20 pounds worth is ſufficient for the ordinary of 100 Men, how many men will 4 *l.* worth ſuffice when it is worth 24 *l. per Tun*? *Anſwer* 25 men.

Queſt. 9. If 6 men in 24 days mow 72 Acres, in how many days will 8 men mow 24 Acres? *Anſwer*, in 6 days.

Queſt. 10. If when the Tun of Wine is worth 30 *l.* 100 Men will be ſatisfied with 20 *l.* worth, I deſire to know what the Tun is worth, when 4 *l.* worth will ſatisfie 25 men at the ſame rate? *Anſwer*, 24 *l. per Tun.*

CHAP. XIV.

The Rule of Three compoſed of five Numbers.

1. THE Rule of Three Compoſed, is, when Queſtions (wherein there are 5 Numbers given to find a 6th in Proportion thereunto) are reſolved by one ſingle Rule of 3 compoſed of the 5 given Numbers.

2. When Queſtions may be performed by the double Rule of 3 Direct, and it is required to reſolve them by the Rule of 3 compoſed, (firſt order or rank your Numbers according to the 7th Rule of the 12th

The

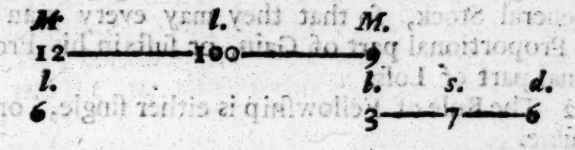
The Rule is,

Multiply the Terms or (Numbers) that ſtand one over the other, in the firſt place, the one by the other, and make their Product the firſt Term in the Rule of Three Direct, then multiply the Terms that ſtand one over the other in the third place, and place their Product for the third Term in the Rule of Three Direct, and put the middle Term of the Three uppermoſt for a ſecond Term; then having found a fourth Proportional, direct to theſe Three, this fourth Proportional ſo found, ſhall be the Anſwer required.

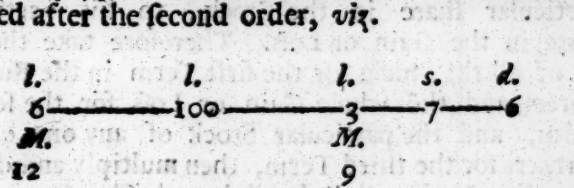
So the firſt Queſtion of the 12*th* Chapter being propoſed, *viz.* If 100 *l.* in 12 Months gain 6 *l.* Intereſt, what will 75 *l.* gain in 9 Months? The Numbers being ranked (or placed) as is there directed and done.

Then I multiply the two firſt Terms, 100 and 12, the one by the other, and their Product is 1200 (for the firſt Term;) then I multiply the two laſt Terms 75 and 9 together, and their Product is 675 for the third Term. Then I ſay, as 1200 is to 6, ſo is 675 to the Anſwer, which by the Rule of Three Direct will be found to be 3 *l.* 7 *s.* 6 *d.* as was before found.

3. But if the Queſtion be to be anſwered by the double Rule of Three Inverſe, then (having placed the five given Terms as before) multiply the lowermoſt Term of the firſt place, by the uppermoſt Term of the third place, and put the Product for the firſt Term; then multiply the uppermoſt Term of the firſt place, by the lowermoſt Term of the third place, and put the Product for the third time, and put the ſecond Term of the three higheſt Numbers for the middle Term to thoſe two, then if the Inverſe Proportion is found in the uppermoſt three numbers, the 4*th* Proportional Direct to theſe three ſhall be the anſwer; ſo the firſt Queſtion of the 13*th* Chapter being ſtated, *viz.* If 100 *l.* Principal in 12 Months gain 6 *l.* Intereſt, what Principal will gain 3 *l.* 7 *s.* 6 *d.* in 9 Months! State the Numbers as is there directed in the firſt order, *viz.*



then reduce the 6 *l.* and 3 *l.* 7 *s.* 6 *d.* into pence, the 6 *l.* is 1440 *d.* and 3 *l.* 7 *s.* 6 *d.* is 810 *d.* then multiply 1440 by 9, the Product is 12960 for the firſt Term in the Rule of Three Direct, and multiply 810 by 12, the Product is 9720 for the third Term, then I ſay, As 12960 is to 130 *l.* ſo is 9720 to the Anſwer, *viz.* 75 *l.* as before. But if the *terms* had been placed after the ſecond order, *viz.*



then the Inverſe Proportion is found in the loweſt Numbers, and having compoſed the Numbers for a ſingle Rule of Three as in the ſecond Rule foregoing, then the Anſwer muſt be found by a ſingle Rule of Three Inverſe, for here it falls out to multiply 810 by 12 for the firſt Number, and 1440 by 9 for the third Number, and then you muſt ſay, as 9720 is to 100 *l.* ſo is 12960 to the Anſwer, which by Inverſe Proportion will be found to be 75 *l.* as before.

The Queſtions in the 12*th* and 13*th* Chapters may ſerve for thy farther experience.

CHAP. XV.

Single Fellowſhip.

1. FELLOWSHIP is that Rule of Plural Proportion, whereby we ballance Accompts depending

pending between divers Persons having put together a general Stock, so that they may every man have his Proportional part of Gain, or sustain his Proportional part of Loss.

2. The Rule of Fellowship is either single, or it is double.

3. The single Rule is when the Stocks propounded are single Numbers without any respect or relation to time, each Partner continuing his Money in Stock for the same time.

4. In the single Rule of Fellowship, the Proportion is, as the whole Stock of all the Partners, is in Proportion to the total Gain or Loss, so is each Mans particular share in the Stock, to his particular share in the Gain or Loss. Therefore take the Total of all the Stocks for the first Term in the Rule of Three, and the whole Gain or Loss for the second Term, and the particular Stock of any one of the Partners for the third Term, then multiply and divide according to the 7th Rule of the 9th Chapter, and the 4th Proportional Number is the particular loss or gain of him whose Stock you made your second number, wherefore repeat the Rule of 3 as often as there are particular stocks, or partners in the question, and the 4th Terms produced upon the several Operations are the respective Gain or Loss of those particular Stocks given, as in the Examples following.

Quest. 1. Two Persons, *viz.* A and B bought a Tun of Wine for 20 *l.* of which A paid 12 *l.* and B paid 8 *l.* and they gained in the Sale thereof 5 *l.* now I demand each Mans share in the Gains according to his Stock?

First, I find the Sum of their Stocks, by adding them together, *viz.* 12 *l.* and 8 *l.*

which are 20 *l.* then according to	12
this Rule I say first, If 20 *l.* (the	8
Sum of their Stocks) Require 5 *l.*	
the total Gain, how much will 12 *l.*	20 *l.*

(the Stock of A) require? Multiply and Divide by the seventh Rule of the ninth Chapter, and the Answer is 3 *l.* for the share of A in the gains;

gains 5, then again I say, If 20 *l.* require 5 *l.* what will 8 *l.* require? The Answer is 2 *l.* which is the *gain* of B. So I conclude that the share of A in the gain is 3 *l.* and the share of B in the gain is 2 *l.* which in all is 5 *l.*

l. l. l.
If 20——5——12
12

20) 60 (3 l.
60

(0)

l. l. l.
If 20——5——8
8

20) 40 (2 l.

Quest. 2. Three Merchants, *viz.* A, B, and C, enter upon a joint Adventure, A put into the common stock 78 *l.* B put in 117 *l.* and C put in 234 *l.* and they find (when they make up their Accompts) that they have gained in all 264 *l.* now I desire to know each Mans particular share in the gains?

First I add their particular stocks together, and their Sum is 429 *l.* then say, If 429 *l.* gain 264 *l.* what will 78 *l.* gain? and what 117 *l.* and what will 234 *l.* (the Stocks of A, B, and C,) gain? Work by 3 several Rules of 3, and you will find that

	l.
	78
	117
	234
Sum	429

			l.
The Gain of	A	is	48
	B		72
	C		144
		Sum	264

Quest.

Quest. 3. Four Partners, *viz.* A, B, C, and D, between them built a Ship which cost 1730 *l.* of which A paid 346 *l.* B 519 *l.* C 692 *l.* and D 173 *l.* and her Freight for a certain Voyage is 370 *l.* which is due to the Owners, or Builders, I demand each Mans share therein according to his Charge in Building her.

Answer,

	l.
A	74
B	111
C	148
D	37
Sum	370

Quest. 4. A, B, and C, enter Partnership for a certain time, A put into the common stock 364 *l.* B put in 482 *l.* C put in 500 *l.* and they gained 867 *l.* now I demand each mans share in the gain Proportionable to his Stock.

Answer,

	l.	s.	d.
A	234	09	$3\frac{354}{1348}$
B	310	09	$5\frac{62}{1348}$
C	322	01	$3\frac{230}{1348}$
Sum	867	00	0

5. To prove the Rule of *Single Fellowship*, add each mans *Particular* gain or loss together, and if the total Sum is equal to the general gain or loss, then is the Work rightly performed, but otherwise it is erroneous. Example, in the first Question of this Chapter, the *Answer* was that the gain of A was 3 *l.* and the gain of B 2 *l.* which added together make 5 *l.* equal to the total gain given.

The Proof of the Rule of Single Fellowship.

If

If in finding out the *particular shares* of the several *Partners*, any thing remain after Division is ended, such remainders must be added together, (they being all Fractions of the same Denomination) and their sum divided by the common Divisor in each Question (*viz.* the total stock) and the quotient add to the *particular gains*, and then if the total Sum is equal to the Total gain the work is right, otherwise not.

As in the fourth Question, the Remainders were 354, 62, and 930, which added together make 1346, which divided by 1345, (the Sum of their Stocks) the Quotient is 1 *d.* which I add to the pence, *&c.* and the sum of their shares is 867 *l.* equal to the total Gain; wherefore I conclude the work is right.

CHAP. XVI.

Double Fellowship.

1. DOUBLE Fellowship is when several Persons enter into *Partnership* for unequal time, that is when every Mans *particular* stock hath relation to a *particular* time.

2. In the double Rule of Fellowship, multiply each *particular* stock by its respective time, and having added the several products together make their sum the first *number* (or *term*) in the Rule of 3, and the total gain or loss the second number, and the product of any ones particular stock by his time, the third *term*, and the 4*th number* in *Proportion* thereunto is his *particular* gain or loss, whose product of stock and time is your third *number*.

Then repeat (as in Single Fellowship) the Rule of 3, as often as there are Products (or Partners) and the 4 *terms* thereby invented are the *numbers* required.

Example.

Quest. 1. A and B enter *Partnership*, A put in 40 *l.* for 3 months, B put in 75 *l.* for 4 months, and they

gained 70 *l.* now I demand each mans ſhare in the gains, proportionable to his ſtock and time? *Anſwer*, A 20 *l.* B 50 *l.*

To reſolve this Queſtion, I firſt multiply the ſtock of A, (*viz.* 40 *l.*) by its time (3 months) and the product is 120, then I multiply the ſtock of B by its time (*viz.* 75 by 4) and it produceth 300, which I add to the Product of A his Stock and Time, and the ſum is 420. Then by the Rule of 3 Direct, I ſay; As 420 (the Sum of the products) is to 70 (the total gain) ſo is 120 (the Product of A his ſtock and time) to 20 *l.* (the *ſhare* of B in the gains.) And ſo much ought each to have for his ſhare.

	l.	l.
	40	75
	3	4
	A 120	B 300
		120
		Sum 420

Queſt. 2. A, B, and C, make a Stock for 12 Months, A put in at firſt 364 *l.* and 4 Months after that he put in 40 *l.* B put in at firſt 408 *l.* and at the end of 7 Months he took out 86 *l.* C put in at firſt 148 *l.* and 3 Months after he put in 86 *l.* more, and 5 months after that he put in 100 *l.* more, and at the end of 12 Months their gain is found to be 1436 *l.* I deſire to know each mans *ſhare* in the gains according to his ſtock and time?

Firſt, I conſider, that the whole time of their *Partnerſhip* is 12 Months. Then I proceed to find out the ſeveral products or ſtock and time as followeth.

A had at firſt 364 *l.* for 4 Months, wherefore their Product is	1456
Then he put in 40 *l.* which with the firſt Sum makes 404 *l.* which continued the remainder of the time, *viz.* 8 Months, and their Product is	3232
The Sum of the products of the ſtock and time of A is	4688

B had 408 l. in 7 months, whose product is 2856

And then took out 86 l. therefore he left in Stock 322 l. which continued the rest of the time, *viz.* five Months, whose product is 1610

The sum of the products of the stock and time of B is 4466

C put in 148 l. for 3 months, whose product being multiplyed is 444

Then he put in 86 l. which added to the first (*viz.* 148) makes 234 l. which lay in stock 5 Months, their product is 1170

Then he put in 100 l. more, to the 334 l. he had in stock which continued the Remainder of the time (*viz.* 4 months) which multiplyed together produce 1336

The Sum of the product of the money and time of C is 2950

B 4466

A 4688

The Total Sum of all the product is 12104

Then I say, as 12104 is to 1436 (the total gain) so is 2950, to the *share* of A in the gains, *&c.* go on as in the foregoing Examples, and you will find their shares in the gain to be as followeth, *viz.*

Answer,

			l.	s.	d.
The share of	A	is	556	03	6 $\frac{6191}{12104}$
	B		529	16	9 $\frac{5496}{12104}$
	C		349	19	8 $\frac{4160}{12104}$
			1436	00	0

Queſt. 3. Three Graſiers, A, B, and C, take a piece of Ground for 46 l. 10 s. in which A put in 12 Oxen for 8 Months, B put in 16 Oxen for 5 months, and C put 18 Oxen for 4 Months, now the queſtion is, what ſhall each man pay of the 46 l. 10 s. for his ſhare in that charge?

Anſwer,

		l.	s.
A	ſhall pay	18	00
B		15	00
C		13	10
		46	10

3. The proof of this Rule is the ſame with that of *Single Fellowſhip*, laid down in the 5*th* Rule of the 15*th* Chapter; and note that,

If a loſs be ſuſtained inſtead of gain amongſt *Partners*, every mans ſhare to be born in the loſs, is to be found after the ſame method as their gain, whether their Stocks be for equal or unequal time.

CHAP. XVII.

Alligation Medial.

1. THE Rule of Alligation is that Rule in plural proportion, by which we reſolve queſtions, wherein is a compoſition or mixture of divers ſimples, as alſo it is uſeful in the compoſition of Medicines both for quantity, quality, and price. And its ſpecies are two, *viz.* Medial and Alternate.

2. Alligation Medial is when having the ſeveral quantities and prices of ſeveral ſimples propounded, we diſcover the mean price or rate of any quantity of the mixture compounded of thoſe ſimples, and the proportion is,

As the ſum of the ſimples to be mingled is to the total value of all the ſimples, ſo is any part or quantity of the Compoſition or Mixture, to its mean Rate or Price.

Queſt. 1. A Farmer mingleth 20 buſhels of Wheat at 5 *s. per* buſhel, and 36 buſhels of Rye at 3 *s. per* buſhel, with 40 buſhels of Barley at 2 *s. per* buſhels, now I deſire to know what one buſhel of that mixture is worth?

To reſolve this Queſtion add together the given quantities and alſo their values, which is 96 buſhels, whoſe total value is 14 *l.* 8 *s.* as appeareth by the Work following, for

buſh.	*l.*	*d.*
20 *of Wheat at* 5 s. per *Buſhel, is*	5	—0
36 *of Rye at* 3 s. per *Buſhel, is*	5	—8
40 *of Barley at* 2 s. per *Buſhel, is*	4	—0

The Sum of the given quantities is 96 *and their value is* ——— 14—8

Then ſay by the Rule of 3 *Direct*, If 96 Buſhels coſt (or is worth) 14 *l.* 8 *s.* what is 1 *Buſhel* worth?

b.	l.	s.	b.
96	14	8	1
	20		

96) 288 (3 *s.*

288 *facit* 3 s. *per buſhel*

(0)

Queſt. 2. A Vintner mingleth 15 Gallons of Canary at 8 *s. per* gallon, with 20 gallons of Malaga at 7 *s.* 4 *d. per* gallon, with 10 gallons of Sherry at 6 *s.* 8 *d. per* gallon, and 24 gallons of White-wine at 4 *s. per* gallon, now I demand what a gallon of that Mixture is worth? work as in the laſt Queſtion, and you will find the Anſwer to be 6 *s.* 2 *d.* 2 *qrs.* $\frac{4}{6}$ *s.*

Queſt. 3. A Grocer hath mingled 3 *C.* of Sugar at 56 *s. per C.* with 3 *C.* of Sugar at 3 *l.* 14 *s.* 08 *d. per C.* and with 6 *C.* at 1 *l.* 17 *s.* 04 *d. per C.* I deſire to know the price of a hundred weight of that mixture? *Anſwer* 2 *l.* 13 *s.* 1 *d.* $\frac{7}{12}$.

3. The proof of this operation is by the price of any quantity of the mixture to find out the total value of the whole compoſition, and if it is equal to the total value of the ſeveral ſimples, the Work is right, otherwiſe not. As in the firſt Example, the anſwer to the queſtion was that 30. is the price of one buſhel, wherefore I ſay by the Rule of Proportion, If 1 buſhel be 3 ſhillings, what is 96 buſhels? *Anſwer* 14 *l.* 8 *s.* which is the total value of the ſeveral ſimples, wherefore the Work is right.

The Proof of Allig. Medial.

CHAP. XVIII.

Alligation Alternate.

1. ALligation Alternate is when there are given the particular prices of ſeveral ſimples, and thereby we diſcover ſuch quantities of thoſe ſimples, as being mingled together ſhall bear a certain rate propounded.

2. When ſuch a queſtion is ſtated, place the given prices of the ſimples one over the other, and the propounded price of the compoſition againſt them in ſuch ſort that it may repreſent a Root, and they ſo many branches ſpringing from it as in the following Example.

Queſt. 1. A certain Farmer is deſirous to mix 20 buſhels of Wheat at 5 *s.* or 60 *d. per* buſhel, with Rye at 3 *s.* or 36 *d. per* buſhel, and with Barley at 2 *s.* or 24 *d. per* buſhel, and Oats at 1 *s.* 6 *d. per* buſhel, and deſireth to mix ſuch a quantity of Rye, Barly and Oats with the 20 buſhels of Wheat, as that the whole compoſition may be worth 2 *s.* 8 *d.* or 32 *d. per* buſhel.

The

The prices of the ſimples being placed according to the laſt Rule, with the price of the compoſition propounded as a root to them will ſtand as followeth.

32 { 60 *pence*
36
24
18

3. Having thus placed the given Numbers you are to link or combine the ſeveral rates of the ſimples the one to the other, by certain Arches, in ſuch ſort that one that is leſſer than the root (or mean rate) may be linked or coupled to another that is greater than the mean rate, ſo the queſtion laſt propounded will ſtand.

1. *Thus*)

2. *Or thus,*

3. *Or thus,*

4. Then take the difference between the root and the ſeveral branches, and place the difference of each againſt the number or branch, with which it is coupled or linked, and having taken all the Differences and placed them as aforeſaid, then thoſe differences ſo placed will ſhew you the number of each ſimple to be taken to make a compoſition to bear the mean rate propounded.

So the branches of the laſt queſtion being linked together as in the firſt manner, I ſay the difference between 32 and 60, is 28, which I put againſt 18, becauſe 60 is linked with 18, then the difference between 32 and 36 is 4, which I

put againſt 24, becauſe 36 is linked or coupled with 24, then I ſay the difference between 32 and 24 is 8, which I place againſt 36 (for the reaſon aforeſaid) then I ſay the difference between 32 and 18 is 14, which I place againſt 60; and then the Work will ſtand as you ſee in the Margent.

So I conclude that a compoſition made of 14 buſhels of Wheat at 60 *d. per* buſhel, and 8 buſhels of Rye at 36 *d. per* buſhel, and 4 buſhels of Barley at 24 *d. per* buſhel, and 28 buſhels of Oats at 18 *d. per* buſhel, will bear the mean price of 32 *d.* or 2 *s.* 8 *d. per* buſhel. And here obſerve that in this compoſition there is but 14 buſhels of Wheat; but I would mingle 20 buſhels, and this kind (or rather caſe) of Alligation Alternate, (*viz.*) when there is given a certain quantity of one of the ſimples, and the quantities of the reſt ſought to mingle with this given quantity, (that the whole may bear a price propounded) is called Alternation partial.

And the proportion to find out the ſeveral quantities to be mingled with the given quantity is as followeth, *viz.*

As the difference annexed to the branch that is the value of an Integer of the given quantity, is to the other particular Differences, ſo is the quantity given to the ſeveral quantities required.

So here, to find out how much Rye, Barley and Oats muſt be mingled with the 20 buſhels of Wheat, I ſay by the ſingle Rule of 3 Direct, If 14 buſhels of Wheat require 8 buſhels of Rye, what will 20 buſhels of Wheat require? *Anſwer*, $11\frac{6}{7}$ buſhels of Rye.

Again, if 14 buſhels of Wheat require 4 buſhels of Barley, what will 20 buſhels of Wheat require? *Anſwer*, $5\frac{1}{7}^{0}$ buſhels of Barley. Again I ſay, if 14 buſhels of Wheat require 28 buſhels of Oats what will 20 buſhels of Wheat require? *Anſwer*, 40 buſhels of Oats.

And now I ſay, that 20 buſhels of Wheat mingled with $11\frac{6}{7}$ buſhels of Rye, and $5\frac{1}{7}^{0}$ buſhels of Barley, and 40 buſhels of Oats, each bearing the Rates as aforeſaid, will make a compoſition or heap of Corn that may yield 32 *d. per* buſhel.

But

But if the branches had been coupled according to the second order, or manner, the differences would have been thus placed, *viz.* the differences between 32 and 60 is 28, which I set against 24, because 60 is linked thereto; and the difference between 32 and 36 is 4, which I set against 18,

32	60	8
	36	14
	24	28
	18	4

and the difference betwixt 32 and 24 is 8, which I set against 60; then the difference between 32 and 18 is 14, which I set against his yoke-fellow 36, and then I conclude that if you mix 8 bushels of Wheat with 14 bushels of Rye, 28 bushels of Barley, and 4 bushels of Oats, each bearing the foresaid prices, the whole mixture may be sold for 32 *d. per* bushel, as by the work in the Margent.

You see by this work we have found how many bushels of Rye, Barley and Oats, ought to be mixed with 8 bushels of Wheat, and to find out how many of each ought to be mixt with 20 bushels of Wheat, I say, as 8 is to 14, so is 20 to 35 bushels of Rye. As 8 is to 28, so is 20 to 70 bushels of Barley. As 8 is to 4, so is 20 to 10 bushels of Oats, whereby I conclude, that if to 20 bushels of Wheat I put 35 bushels of Rye, 70 bushels of Barley, and 10 bushels of Oats, bearing each the foresaid prices *per* bushel, that then a bushel of this mixture will be worth 32 *d.* or 2 *s.* 8 *d.*

And if the branches had been linked as you see in the third place, where each branch bigger than the root, is linked to two that are lesser than the root, then in this case you must have placed the several differences between the root and branches, against those two with which each is coupled, as first the difference between 32 and 60 is 28, which I put against 24 and 18 because it is coupled,

32	60	8,14	22
	36	8,14	22
	24	28,4	32
	18	28,4	32

with them both, then the difference between 32 and 36 is 4, which I set likewise against 24 and 18, because 36 is linked to them both, then the difference between 32 and 24 is 8, which I put against 60 and 36, because 24 is linked to them both, then the difference between 32 and 18 is 14, which I put against 60 and 36, the yoke follows of 18.

Lastly, I draw a line behind the differences, and add differences which stand against each branch, and put the Sum behind the said line against its proper branch, as you see in the Margent.

And now by this work I find that 22 bushels of the Wheat mingled with 22 bushels of Rye, and 32 bushels of Barly, and 32 bushels of Oats, each bearing the said price will make a mixture, bearing the mean rate of 32 *d. per* bushel.

And to find how much of each of the rest must be mingled with 20 bushels of Wheat, I say,

As 22 is to 22, so is 20 to 20 bushels of Rye. As 22 is to 32, so is 20 to $29\frac{2}{11}$ bushels of Barly. As 22 is to 23, so is 20 to $29\frac{3}{11}$ bushels of Oats.

Whereby you see the questions of Alligation Alternate will admit of more true answers than one; for we have found three several answers to this first question.

The Proof of Alternation partial.

Questions of Alternation partial are proved the same way with Questions in Alligation medial which you may see in the 3*d* Rule of the 17*th* Chapter.

Quest. 2. A Grocer hath 4 sorts of Sugar, *viz.* of 12 *d. per l.* of 10 *d. per l.* of 6 *d per l.* and of 4 *d. per l.* and he would have a composition worth 8 *d. per l.* the whole Quantity whereof should contain 144 *l.* made of these 4 sorts, I demand how much of each he must take?

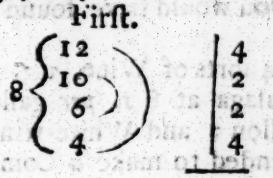
Questions of this Nature are resolved by that part of Alligation alternate called by Arithmeticians Alternation total, *viz.* where there is given the sum, and prices of several simples to find out how much of each simple ought to be taken to make the said sum or

quantity

quantity, ſo that it may bear a certain Rate propounded.

To reſolve this queſtion I place the ſeveral prices of the ſimples and mean rate propounded, and link them together, as is directed in the 2 and 3 Rules of this Chapter, and place the differences between the root and branches according to the 4*th* Rule of this Chapter, which will then ſtand one of theſe three ways, *viz.*

First.



Second.

Third.

5. Then add the ſeveral differences together, which I have done, and the ſums of the firſt and ſecond order are 12 *l.* and of the third 24 *l.* as you may ſee above, but it is required that there ſhould be 144 *l.* of the compoſition, therefore to find the quantity of each ſimple, to make the whole compoſition 144 *l.* obſerve this general Rule, *viz.*

As the ſum of the differences is to the ſeveral differences, ſo is the total quantity of the compoſition to the quantity of each ſimple.

So to find how much of each ſort of Sugar I ought to take to make 144 *l.* at 8 *d. per l.* I ſay,

l.

As 12 is to 4, ſo is 144 to 48 *l.* at 12 *d. per l.*
As 12 is to 2, ſo is 144 to 24 *l.* at 10 *d. per l.*
As 12 is to 2, ſo is 144 to 24 *l.* at 6 *d. per l.*
As 12 is to 4, ſo is 144 to 58 *l.* at 4 *d. per l.*

Whereby

Whereby I find that 48 *l.* at 12 *d. per l.* and 24 *l.* at 10 *d. per l.* and 24 *l.* at 6 *d. per l.* and 48 *l.* at 4 *d. per l.* will make a compoſition of Sugar containing 144 *l.* worth 8 *d. per l.*

But as the branches are linked in the ſecond order, the anſwer will be 24 *l.* at 12 *d. per l.* and 48 *l.* at 10 *d. per l.* and 48 *l.* at 6 *d. per l.* and 24 *l.* at 4 *d. per l.* to make the ſaid quantity, and to bear the ſaid price.

And if you had worked as the Branches are linked after the third order, then you would have found the quantity of 36 *l.* of each.

Queſt. 3. A Vintner hath 4 ſorts of Wine, *viz.* Canary at 10 *s. per* Gallon, Malaga at 8 *s. per* gallon; Rheniſh-wine at 6 *s. per* gallon; and White-wine at 4 *s. per* gallon, and he is minded to make a Compoſition of them all of 60 gallons that may be worth 5 ſhillings *per* Gallon, I deſire to know how much of each he muſt have?

The numbers or terms being ranked according to the ſecond Rule of this Chapter, the branches will be linked as followeth, and will admit of no other manner of coupling, becauſe there is but one branch that is leſſer than the Root, therefore all the reſt muſt be linked unto it; and the differences between the Root and the three firſt branches, *viz.* 10, 8, and 6, which are 5, 3, and 1, muſt be ſet againſt 4 becauſe they are all coupled with it, and the difference between the Root (*viz.* 5.) and 4, which is 1, muſt be ſet againſt the 3 other, becauſe it is linked to them all; ſo I find 1 gall. of Canary, 1 gallon of Malaga, 1 gallon of Rheniſh Wine, and 9 gallons of White-wine, prized as above being mingled together, will be worth 5 *s. per* gallon, the Sum being 12 gallons; but there muſt be 60 gallons, wherefore I ſay,

As 12 is to 1, ſo is 60 to 5 gallons of Canary.
As 12 is to 1, ſo is 60 to 5 gallons of Malaga.
As 12 is to 1, ſo is 60 to 5 gallons of Rheniſh.
As 12 is to 9, ſo is 60 to 45 gall. of White-wine.

So that 5 gallons of Canary, 5 gallons of Malaga, 5 gallons of Rhenish, and 45 gallons of White-wine mingled together, will be in all 60 gallons, worth 5 *s.* *per* gallon, which was required.

Quest. 4. A Goldsmith hath Gold of 4 several sorts of fineness, *viz.* of 24 *Carects* fine, and of 22 *Carects* fine, of 20 *Carects* fine, and of 15 *Carects* fine. And he would mingle so much of each with alloy, that the whole Mass of 28 ounces of Gold so mingled may bear 17 *Carects* fine. I demand how much of each he must take, the second and third Rules of this Chapter being observed, (for instead of the alloy I put 0, because it bears no fineness, but it makes a branch in the Operation) the terms may be alligated and the differences added any of these 4 ways following, *viz.*

Read Chap. 2. diff. 2. of this Book.

First thus,

24	17	17
22	2	2
17 20	1, 17	19
15	5, 3	8
0	7, 3	10

Sum 56

Secondly thus,

24	2	2
22	17	17
17 20	2, 17	19
15	7, 3,	10
0	5, 3,	8

Sum 56

Thirdly thus,

24	2,	2
22	2,	2
17 20	2, 17	19
15	7,5,3,	15
0	3,	3

Sum 41

Fourthly,

Fourthly thus,

Sum 87

More ways may be given for the Alligating, or linking of the *Terms* in this Queſtion, but theſe are ſufficient for the induſtrious, and it ſhall alſo ſuffice to give an anſwer to the queſtion as the terms are link'd the firſt way, not doubting but the ingenious practitioner will be able at his leiſure to find Anſwers to the other 3 ways, *viz.*

	oz.	*p.w.*	*car.*
As 56 is to 17, ſo is 28 to	8	10	of 24
As 56 is to 2, ſo is 28 to	1	00	of 22
As 56 is to 19, ſo is 28 to	9	10	of 20
As 56 is to 18, ſo is 28 to	4	00	of 15
As 56 is to 10, ſo is 28 to	5	00	of alloy

Thus much well practiſed and underſtood is ſufficient for the underſtanding of Alligation.

The proof of Alternation Total.

In queſtions of Alternation Total, the Anſwer given is true, when the ſum of each of the quantity of ſimples found, agrees with the Sum or Quantity propounded; as in the laſt Queſtion, the Anſwer was 8 *oz.* 10 *p.w.* of 24 Carects fine, 10 *oz.* of 22 Carects fine, 9 *oz.* 10 *p.w.* of 20 Carects fine, 4 *oz.* of 15 Carects fine, and 5 *oz.* of Alloy, which added together make 28 *oz.* the quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

WHat a Vulgar Fraction is, and its parts and ſeveral kinds, hath been already ſhewed in the 19, 20, 21, 22, 23, 24, and 31 definitions of the firſt

firſt Chapter of this Book, which the Learner is deſired diligently to obſerve before he proceeds.

2. To reduce a Vulgar Fraction (which diſcovereth the principal knowledge of Fractions, and therefore ought greatly to be regarded) we ſhall diſcover plainly under theſe eight ſeveral heads (or Rules) following, *viz.*

1. To reduce a mixt number into an improper Fraction.
2. To reduce a whole Number into an improper Fraction.
3. To reduce an improper Fraction into its equivalent whole (or mixt) number.
4. To reduce a Fraction into its loweſt terms equivalent to the Fraction given.
5. To find the value of a Fraction in the known parts of Coyn, Weight, Meaſure, *&c.*
6. To reduce a compound Fraction to a ſimple one of the ſame value.
7. To reduce divers Fractions having unequal denominators, to Fractions of the ſame value, having an equal Denominator.
8. To reduce a Fraction of one denomination to another of the ſame value.

I. *To reduce a mixt Number to an improper Fraction.*

The Rule is, *Vide Chap.* 1. *defin.* 31.

Multiply the Integral part (or whole Number by) the denominator of the Fraction, and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator; ſo this new Fraction ſhall be equal to the mixt Number given. As for Example.

1. Reduce $18\frac{3}{7}$ into an improper Fraction, multiply the whole number 18 by 7 the denominator, and to the Product add the numerator 3, the ſum is 129, which put over the denominator 7, and it makes $\frac{129}{7}$ for the anſwer as followeth.

$18\frac{3}{7}$
7
129
facit 129

2. Reduce $183\frac{5}{21}$ to an improper *fraction*, *facit* $\frac{3848}{21}$.
3. Reduce $56\frac{13}{23}$ to an improper *fraction*, *facit* $\frac{1189}{21}$.

II. *To reduce a whole Number to an improper Fraction.*

The Rule is,

Multiply the given *Number*, by the intended *denominator*, and place the product for a *numerator* over it. As for *Example*.

Vide Chap. 1. *defin.* 23.

1. Let it be required to reduce 15 into a Fraction whose denominator shall be 12. To effect which, I multiply 15 by the intended denominator (12) the product is 180, which I place over 12 as a numerator, and it makes $\frac{180}{12}$ which is equal to 15, as was required; as *per* Margent.

15
12
30
facit $\frac{180}{12}$ 15
180

2. Reduce 36 into an improper Fraction whose denominator shall be 26, *facit* $\frac{936}{26}$.
3. Reduce 135 into an improper Fraction, whose denominator shall be 16, *facit* $\frac{2160}{16}$.

III. *To reduce an improper Fraction into its equivalent whole or mixt number.*

The Rule is,

Divide the Numerator by the Denominator, and the Quotient is the whole number equal to the fraction, and if any thing remain, put it for a Numerator over the Divisor. Example, 1. Reduce

1. Reduce $\frac{436}{8}$ into its equivalent mixt number, divide the Numerator 436 by the denominator 8, and the Quotient is 54, and 4 remains, which put for a Numerator over the Divisor 8, the Answer is $54\frac{4}{8}$ as followeth.

8) 436 (54
40
36
32
4

facit $54\frac{4}{8}$

2. Reduce $34\frac{76}{15}$ to a mixt number, *facit* $231\frac{11}{15}$.
3. Reduce $15\frac{576}{1376}$ to a mixt number, *facit* $114\frac{72}{172}$.

IV. *To Reduce a Fraction into its lowest terms equivalent to the Fraction given.*

The Rule is,

1. If the *numerator* and *denominator* are even *numbers*, take half of the one, and half of the other as often as may be, and when either of them falls out to be an odd number, then divide them by any number that you can discover will divide both *numerator* and *denominator* without any Remainder; and when you have thus proceeded as low as you can reduce them, then this new Fraction so found out shall be the *fraction* you desire, and will be in value equal to the given Fraction. Example.

1. Let it be required to reduce $\frac{192}{336}$ into its lowest terms. First, I take the half of the *Numerator* 192 and it is 96, then half of the *Denominator* and it is 168, so that now it is brought to $\frac{96}{168}$, and next to $\frac{48}{84}$, and by halfing still to $\frac{24}{42}$, and their half is $\frac{12}{21}$, and now I can no longer half it, because 21 is an odd *number*, wherefore I try to divide them by 3, 4, 5, 6, *&c.* and I find 3 divides them both without any remainder, and brings them to $\frac{4}{7}$ as *per*

192	96	48	24	12	4
336	168	84	42	21	6

So I conclude $\frac{4}{7}$ thus found to be equal in value to the given *fraction* $\frac{1}{3}\frac{9}{3}\frac{3}{6}$.

2. What is $\frac{1}{4}\frac{0}{7}\frac{3}{8}\frac{6}{4}$ in its lowest terms? *Answer* $\frac{7}{8}$.

3. What is $\frac{1}{1}\frac{2}{5}\frac{4}{8}\frac{3}{4}$ in its lowest terms? *Answer* $\frac{1}{1}\frac{3}{5}$.

There is yet another way more excellent than the former to reduce a *fraction* into its lowest terms, and that is by finding a common Measurer, *viz.* the greatest *number* that will divide the *numerator* and *denominator* without any remainder, and by that means reduce a *fraction* to its lowest terms at the first work; and to find out this common measurer divide the *denominator* by the *numerator*, and if any thing remains divide your Divisor thereby; and if any thing yet *remains*, then divide your last Divisor by it; do so until you find nothing *remains*; then this last divisor shall be the greatest common measurer, which will divide both *numerator* and *denominator*, and reduce them into their lowest terms at one Work. *Vide Ought. Cla. Matth. cap.* 7.

Example.

4. Reduce $\frac{2}{3}\frac{2}{0}\frac{8}{4}$ into its lowest terms by a common measurer. To effect which I divide the *denominator* 304 by the *numerator* 228 and there remains 76, then I divide 228 (the first Divisor) by 76 (the *Remainder*) and it quotes 3, and nothing *remains*; wherefore the last Divisor 76 is the common measurer, by which I divide the *numerator* of the given *Fraction*, *viz.* 228, it quotes 3 for a new *numerator*, then I divide the *denominator* 304 by 76 and it quotes 4 for a new *denominator*, so that now I have found $\frac{3}{4}$ equal to $\frac{2}{3}\frac{2}{0}\frac{8}{4}$.

5. Reduce $\frac{6}{7}\frac{0}{3}\frac{4}{9}\frac{8}{2}$ into its lowest terms by a common measurer, *facit* $\frac{9}{11}$.

6. Reduce $\frac{3}{2}\frac{0}{0}\frac{3}{8}\frac{8}{2}\frac{1}{2}$ into its lowest terms by a common measurer, *facit* $\frac{13}{86}$.

A Compendium.

Note that if the *numerator* and *denominator* of a *fraction*, and each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the *remaining* figures will be a *fraction* of the same value, *viz.* $\frac{1400}{7100}$ will be found to be reduced to $\frac{14}{71}$

by cutting off the 2 Cyphers from the *numerator* and *denominator*, with a dash of the Pen, thus, $\frac{34}{71}|\frac{00}{00}$, and $\frac{46}{70}|\frac{00}{00}$, will be $\frac{46}{70}$ thus $\frac{46}{70}|\frac{00}{00}$, *&c.*

V. *To find the Value of a Fraction in the known parts of Coyn, Weight, &c.*

The Rule is,

Multiply the *numerator* by the parts of the next inferiour *denomination* that are equal to an Unit of the ſame *denomination* with the *Fraction*, then divide that Product by the *denominator*, and the quote gives you its value in the ſame parts you multiplied by, and if any thing remain multiply it by the parts of the next inferiour *denomination*, and divide as before, do ſo till you can bring it no lower, and the ſeveral quotients will give you the value of the *fraction* as was required, and if any thing at laſt remain, place it for a *numerator* over the former *denominator*, ſome few Examples will make the Rule plain.

1. What is the value of $\frac{27}{29}$ *l. Sterling*? To anſwer this Queſtion I multiply the numerator 27 by 20 (the ſhillings in a pound) the product is 540, which I divide by 29 (the denominator) and the Quotient is 18 *s.* and there remains 18 which I multiply by 12 pence, and the product (216) I divide by the denominator 29, the Quotient is 7 *d.* and 13 remains, which I multiply by 4 Farthings, the product is 52, which I ſtill divide by 29, the Quotient is 1 Farthing, and there remaineth 23, which I put for a Numerator over the denominator 29, ſo I find the value of $\frac{27}{29}$ *l.* to be 18 *s.* 7 *d.* 1 *qr.* $\frac{23}{29}$, as by the following Operation, and after the ſame manner are the values of the fractions in the ſeveral examples following found out.

What is $\frac{27}{29}$ *l.*

$\frac{27}{29}$ *l.*
27
Multiply 20
29) 540 (18 *s.*
29
250
232
Remains (18)
Multiply 12
36
18
29) 216 (7 *d.*
203
Remains (13)
Multiply 4
qr.
29) 52 ($1\frac{23}{29}$
29
Remains (23)

	s.	*d.*	*qr.*
Facit	18	7	$1\frac{23}{29}$

2. What is the value of $\frac{21}{25}$ *l. Sterling? facit* 14 *s.* 8 *d.*
3. What is the value of $\frac{28}{247}$ *l. Sterling? facit* 4 *s.* 1 *d.* $\frac{7}{13}\frac{7}{7}$.
4. What is $\frac{126}{224}$ *C.* weight? *facit* 3 *qrs.* 1 *l.* 5 *oz.* $\frac{7}{21}$.
5. What is $\frac{136}{371}$ *l. Troy* weight? *facit* 4 *oz.* 7 *p.w.* 23 *gr.* $\frac{179}{371}$.
6. What is $\frac{41}{50}$ of a year? *Answer*, 299 *da.* 7 *h.* 12 *min.*

VI. *To Reduce a compound Fraction to a ſimple one of the ſame value.*

What a compound Fraction is, hath been ſhewed in Chap. 1. Definition 24, and to reduce it to a ſimple Fraction of the ſame value.

The Rule is,

Multiply the Numerator continually, and place the laſt product for a new Numerator, then multiply the Denominators continually, and place the laſt product for a new denominator, ſo this ſingle Fraction ſhall be equal to the compound Fraction given. Example.

1. Reduce $\frac{2}{3}$ of $\frac{1}{5}$ of $\frac{3}{8}$ to a ſimple Fraction.

Multiply the Numerators 2, 3, and 5, together, they make 30 for a new Numerator; then I multiply the denominators 3, 5, and 8 together, and their product is 120 for a denominator, ſo the ſimple Fraction is $\frac{30}{120}$, and cutting off the Cyphers it is $\frac{3}{12}$ equal to $\frac{1}{4}$ by the fourth Rule foregoing.

$$\begin{array}{r} 2 \\ 3 \\ 5 \\ \hline 30 \end{array} \qquad \begin{array}{r} 3 \\ 5 \\ 8 \\ \hline 120 \end{array}$$

Facit $\frac{30}{120}$ or $\frac{3}{12}$ or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{6}$ of $\frac{4}{7}$ of $\frac{11}{12}$? *Answer,* $\frac{1540}{5040}$ or $\frac{154}{504}$ or $\frac{77}{252}$ in its leaſt terms.

3. What is $\frac{11}{14}$ of $\frac{13}{14}$ of $\frac{21}{29}$? *Answer,* $\frac{3003}{5887}$.

By this you may know how to find the value of a Compound Fraction, *viz.* firſt reduce it to a ſimple one, and then find out his value by the 5*th* Rule foregoing.

Example.

Example.

What is the value of $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{9}{10}$ of a pound? *Answer*, 11 *s.* 3 *d.*

VII. *To reduce Fractions of unequal Denominators to Fractions of the same Value, having equal Denominators.*

The Rule is,

Multiply all the Denominators together, and the Product shall be the Common Denominator. Then multiply each Numerator into all the Denominators except its own, and the last Product put for a Numerator over the Denominator found out as before. So this new Fraction is equal to that Fraction, whose Numerator you multiplyed into the said Denominators. Do so by all the Numerators given, and you have your desire.

Example.

1. Reduce $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{7}{8}$ to a common Denominator.

Multiply the Denominators 4, 5, 6, and 8, together continually, and the product is 960 for the common Denominator; then multiply the Numerator 3 into the Denominators, 5, 6, and 8, and the product is 720, which is a Numerator to 960 (found as before) so $\frac{720}{960}$ is equal to the first Fraction $\frac{3}{4}$, then I proceed to find a new Numerator to the second Fraction, *viz.* $\frac{4}{5}$, and I multiply 4 (into all the Denominators except its own; *viz.*) into 4, 6, and 8, which produceth $\frac{768}{960}$ equal to $\frac{4}{5}$, then multiply the numerator 5 into the denominators 4, 5, and 8, the product is $\frac{800}{960}$ equal to $\frac{5}{6}$. Then multiply the Numerator 7 into the Denominators 4, 5, and 6, the product is $\frac{840}{960}$ equal to $\frac{7}{8}$, and the work is done; so that for $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{9}$ and $\frac{7}{8}$, I have $\frac{720}{960}$, $\frac{768}{960}$, $\frac{800}{960}$, $\frac{840}{960}$.

2. Reduce $\frac{11}{12}$, $\frac{14}{23}$, and $\frac{19}{21}$ into a common denominator, *faciunt* $\frac{5313}{5796}$, $\frac{3528}{5796}$, and $\frac{5244}{5796}$.

VIII. *To*

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either Ascending, or Descending. Ascending when a Fraction of a smaller is brought to a greater Denomination, and Descending when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a lesser to a greater Denomination, then make of it a Compound Fraction by comparing it with the intermediate Denominations between it, and that you would have it reduced to, then (by the 6th Rule foregoing) reduce your Compound to a simple Fraction, and the Work is done. Example,

Quest. 1. It is required to know what part of a pound *sterling* $\frac{4}{7}$ of a peny is?

To resolve this, I consider that 1 *d.* is $\frac{1}{12}$ of a shilling, and a shilling is $\frac{1}{20}$ of a pound; wherefore $\frac{4}{7}$ *d.* is $\frac{4}{7}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound, which by the said 6th Rule I find to be $\frac{4}{1680}$ of a *l. sterling* of *English* Money.

Quest. 2. What part of a pound *Troy* weight is $\frac{5}{7}$ of a penny weight? *Answer,* $\frac{5}{7}$ of $\frac{1}{20}$ of $\frac{1}{12}$ *l.* equal to $\frac{5}{1680}$ *Troy.*

3. When a Fraction is to be brought from a greater to a lesser denomination, then multiply the Numerator by the parts contained in the several denominations betwixt it; and that you would reduce it to; then place the last product over the denominator of the given Fraction. Example,

Quest. 3. I would reduce $\frac{3}{5}$ *l.* to the Fraction of a Peny; to do which I multiply the Numerator 3 by 20 and 12, the product is 720, which I put over the Denominator 5, it makes $\frac{720}{5}$ of a peny, equal to $\frac{3}{5}$ *l.*

Quest. 4. What parts of an Ounce *Troy* is $\frac{5}{16}$ *l.*? *Answer,* $\frac{60}{16}$ *oz.*

CHAP.

CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their sum for a Numerator to the common Denominator, which new Fraction is the Sum of all the given Fractions; and if it be improper, reduce it to a whole or mixt Number, by the 3*d* Rule of the 19*th* Chapter.

Quest. 1. What is the Sum of $\frac{1}{24}$, $\frac{7}{24}$, $\frac{16}{24}$, and $\frac{14}{24}$?

The Denominators are equal, *viz.* every one is 24, wherefore add the Numerators together, *viz.* 7, 9, 16 and 14, their Sum is 46, which put over the Denominator 24, it makes $\frac{46}{24}$ the Sum of the given Fractions, which will be reduced to the mixt Number $1\frac{22}{24}$, or $1\frac{22}{12}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7*th* Rule of the 19*th* Chap. and then add the Numerators together, and put the Sum over the common Denominator, *&c.* as before in the last Example.

Quest. 2. What is the Sum of $\frac{3}{5}$, $\frac{7}{8}$, $\frac{9}{10}$, and $\frac{11}{12}$?

The Fractions reduced to a common Denominator are $\frac{2880}{4800}$, $\frac{4200}{4800}$, $\frac{4320}{4800}$, and $\frac{4400}{4800}$, the Sum of their Numerators is 15800, which put over the common Denominator, makes $\frac{15800}{4800}$ or $\frac{158}{48}$ equal to the mixt number $3\frac{14}{48}$, or $3\frac{7}{24}$ for the Sum required.

Quest. 3. What is the Sum of $\frac{13}{19}$, $\frac{21}{49}$, and $\frac{36}{47}$? *Answer*, $1\frac{37555}{39151}$.

3. If you are to add mixt numbers together, then add the fractional parts as before, and if their Sum be an improper Fraction reduce it to a mixt number, and add its Integral part to the Integral parts of the given mixt Numbers, and the Work is done.

Quest. 4. What is the sum of $13\frac{3}{4}$ and $24\frac{5}{8}$?

First

First add the fractions $\frac{3}{4}$ and $\frac{5}{8}$, the sum is $1\frac{12}{24}$, then add this Integer 1, to 13 and 24, their sum is 38, and put after it the fraction $\frac{12}{32}$ it is $38\frac{12}{32}$ for the *Answ.* or it is $38\frac{3}{8}$.

Queſt. 5. What is the Sum of $48\frac{3}{7}$, $64\frac{5}{8}$ and $130\frac{3}{4}$? *Facit* $243\frac{1840}{224}$, or $243\frac{45}{56}$.

4. If any of the Fractions to be added is a Compound Fraction, it muſt firſt be reduced to a ſimple Fraction by the *6th* Rule of Chapter 19, and then add it to the reſt according to the *2d* Rule of this Chapter. Example,

Queſt. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$?

Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a ſimple fraction, and it is $\frac{105}{192}$, which reduced with the other two, and added are $1\frac{46}{56}\frac{86}{80}$.

Queſt. 7. What is the Sum of $\frac{11}{12}$ and $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$? *Anſwer,* $1\frac{5}{12}$.

5. If the fractions to be added are not of one denomination, they muſt be ſo reduced, and then proceed as before.

Queſt. 8. What is the Sum of $\frac{3}{4}$ *l.* and $\frac{5}{6}$ *s.*?

Of the given fractions here, one is of a pound and the other the fraction of a ſhilling; and before you can add them together, you muſt reduce $\frac{5}{6}$ *s.* to the fraction of a pound as the other is (by the *8th* Rule of Chapter 19) and it makes $\frac{5}{120}$ *l.* then $\frac{3}{4}$ *l.* and $\frac{5}{120}$ *l.* will be found to be $\frac{380}{480}$ *l.* or $\frac{38}{48}$ *l.* by the *7th* Rule of Chapter 19, and in its loweſt terms $\frac{19}{24}$ *l.* by the *4th* Rule of Chapter 19.

It would have been the ſame, if (by the latter part of the *8th* Rule of Chapter 19) you had reduced $\frac{3}{4}$ *l.* to the fraction of a ſhilling, which you would have found to have been $\frac{60}{4}$ *s.* which added to $\frac{5}{6}$ *s.* by the ſaid *17th* Rule of the laſt Chap. the Sum is 15 *s.* $\frac{300}{240}$, which is equal to the Sum found as before, *viz.* $\frac{19}{24}$ *l.* for (by the *5th* Rule of Chapter 19) the value of $\frac{19}{24}$ *l.* will be found to be 15 *s.* 10 *d.* and ſo will 15 *s.* $\frac{20}{24}$ be found to be juſt as much.

Queſt. 9. What is the Sum of $\frac{2}{3}$ *l.* $\frac{3}{5}$ *s.* and $\frac{3}{5}$ *d* *Anſwer* $\frac{3795}{6000}$ or $\frac{3795}{6000}$ *l.* or in its loweſt terms $\frac{253}{400}$ *l.*

CHAP. XXI.

Subſtraction of Vulgar Fractions.

1 THE Rules in Addition for reducing the given Fractions to one *denomination*, are here to be obſerved; for before *Subſtraction* can be made, the *fractions* muſt be reduced to a common *denominator*, then *ſubſtract* one *Numerator* from the other, and place the *remainder* over the common *denominator*, which *fraction* ſhall be the exceſs or difference between the given *fractions*. Example,

Queſt. 1. What is the difference between $\frac{3}{4}$ and $\frac{5}{7}$? The given *fractions* are reduced to $\frac{21}{28}$ and $\frac{20}{28}$, then *ſubſtract* the *numerator* 20 from the *numerator* 21, and there remains 1, which being put over the *denominator* 28, makes $\frac{1}{28}$ for the anſwer or difference between $\frac{3}{4}$ and $\frac{5}{7}$.

Queſt. 2. What is the difference between $\frac{5}{6}$ and $\frac{3}{5}$ of $\frac{5}{8}$?

Reduce the compound *fraction* $\frac{3}{5}$ of $\frac{5}{8}$ to a ſimple *fraction*, then proceed as before, and the anſwer is $\frac{110}{240}$ equal to $\frac{11}{24}$.

2. When a *fraction* is given to be *ſubſtracted* from a whole *number*, *ſubſtract* the *numerator* from the *denominator*, and put the *remainder* for a *numerator* to the given *denominator*, and *ſubſtract* an Unit (for that you borrowed) from the whole number, and the remainder place before the *fraction* found as before, which mixt number is the remainder or difference ſought. Example,

Queſt. 3. *Subtract* $\frac{7}{10}$ from 48.

Anſw. $47\frac{3}{10}$; for if you *ſubtract* 7 (the *numerator*) from 10 (the *denominator*) there remains 3, which put over 10 is $\frac{3}{10}$ and 1 (I borrowed) from 48 reſts 47, to which join $\frac{3}{10}$ and it makes $47\frac{3}{10}$ for the exceſs.

Queſt. 4. *Subtract* $\frac{13}{21}$ from 57, *remains* $56\frac{8}{21}$.

3. If

3. If it is required to *ſubtract* a *fraction* from a mixt number, or one mixt number from another, reduce the *fractions* to a common *denominator*, and if the *fraction* to be *ſubtracted* be leſſer than the other, then *ſubtract* the leſſer numerator from the greater, and that is a numerator for the common denominator; then *ſubtract* the leſſer integral part from the greater, and the *remainder* with the remaining *fraction* thereto annexed, is the Difference required between the two given mixt numbers. Example,

Queſt. 5. *Subtract* $26\frac{3}{7}$ from $54\frac{5}{6}$.

Firſt, *Subtract* $\frac{3}{7}$, *viz.* $\frac{18}{42}$ from $\frac{5}{6}$, *viz.* $\frac{35}{42}$, the remainder is $\frac{17}{42}$, then 26 from 54 remaineth 28, to which annex $\frac{17}{42}$, it makes $28\frac{17}{42}$ for the *Anſwer*.

4. But if the *fraction* to be ſubtracted is greater than the Fraction from whence you ſubtract, then having firſt reduced the Fractions to a common denominator, take the numerator of the greater Fraction out of the denominator, and add the remainder to the numerator of the leſſer Fraction, and their Sum is a new numerator to the common denominator, which fraction note, then (for the 1 you borrowed) add 1 to the Integral part to be ſubtracted, and ſubtract it from the greater number, and to the remainder annex the fraction you noted before, ſo this new mixt number ſhall be the difference ſought. Example,

Queſt. 6. Subtract $14\frac{3}{4}$ from $29\frac{4}{7}$.

The fractions reduced are, *viz.* $\frac{3}{4}$ equal to $\frac{21}{28}$, and $\frac{4}{7}$ equal to $\frac{16}{28}$, now I ſhould ſubtract $\frac{21}{28}$ from $\frac{16}{28}$, but I cannot, therefore I ſubtract 21 from 28 reſts 7, which added to 16 (the leſſer numerator) makes 23 for a numerator to 28; *viz.* $\frac{23}{28}$, then I come to the Integral parts 14 and 29, and ſay 1 that I borrowed and 14 is 15, which taken from 29 there reſts 14, to which annexing $\frac{23}{28}$ it is $14\frac{23}{28}$ for the remainder or difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Queſt. 7. *Subtract* $36\frac{9}{10}$ from $74\frac{4}{5}$ *facit* $37\frac{4}{5}$.

CHAP. XXII.

Multiplication of Vulgar Fractions.

1. IF the Multiplicand and Multiplier are ſimple (or ſingle) Fractions, then multiply the numerators together for a new numerator, and the denominators for a new denominator, which new Fraction is the product required.

Queſt. 1. What is the product of $\frac{5}{7}$ by $\frac{9}{11}$? *facit* $\frac{45}{77}$.

For the numerators 5 and 9 being multiplyed make 45, and the denominators 7 and 11 being multiplyed make 77.

Queſt. 2. What is the product of $\frac{18}{23}$ by $\frac{21}{37}$? *ja.* $\frac{378}{851}$.

2. If the Fractions to be multiplyed are mixt numbers reduce them to improper Fractions by the *1ſt.* Rule of the *19th* Chapter, then proceed as before.

Queſt. 3. What is the product of $48\frac{3}{5}$ by $13\frac{5}{8}$?

The given mixt numbers being reduced to improper fractions are $48\frac{3}{5}$ equal to $^{243}/_{5}$, and $13\frac{5}{8}$ equal to $^{83}/_{8}$, now $^{243}/_{5}$ multiplyed by $^{83}/_{8}$ according to the firſt Rule of this Chapter, produceth $^{20169}/_{40}$ or $672\frac{9}{40}$.

Queſt. 4. What is the product of $430\frac{6}{10}$ by $18\frac{3}{7}$? *facit* $^{55474}/_{70}$ or $7935\frac{24}{70}$.

3. If a compound Fraction is to be multiplied by a ſimple Fraction, firſt reduce the compound fraction into a ſimple fraction, then multiply the one by the other, as is taught above.

Queſt. 5. What is the product of $\frac{16}{21}$ by $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$? the Compound Fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$ reduced is $^{60}/_{140}$ or $^{6}/_{14}$ which multiplyed by $\frac{16}{21}$ produceth $^{96}/_{294}$ which in its loweſt terms is $\frac{16}{49}$ for the Anſwer.

And if the Multiplicand and Multiplyer are both compound fractions, reduce them both to ſimple ones, then multiply theſe new fractions as before, ſo have you the product.

Queſt. 6. What is the product of $\frac{3}{4}$ of $\frac{2}{3}$ by $\frac{3}{5}$ of $\frac{1}{2}$?

Anſwer, $^{18}/_{120}$ in its loweſt terms $\frac{3}{20}$.

Queſt. 7. What is the product of $\frac{2}{3}$ of $\frac{3}{4}$ by $\frac{2}{5}$ of $\frac{5}{8}$?

Anſw.

Answ. $\frac{6}{30}$ or $\frac{6}{30}$, or in its least terms $\frac{1}{6}$.

4. If a Fraction be to be multiplyed by a whole number, put under the given whole number an Unit for a Denominator, whereby it will be an improper Fraction, then multiply these Fractions as before. Example.

Quest. 8. What is the Product of 24 by $\frac{2}{3}$?

Answ. 48, for 24 by putting an Unit under it will be $\frac{24}{1}$, and $\frac{24}{1}$ by $\frac{2}{3}$ produceth $\frac{48}{3}$ or 16.

Quest. 9. What is the Product of 36 by $\frac{9}{11}$? *Answer,* $3\frac{24}{11}$ or $29\frac{5}{11}$

CHAP. XXIII.

Division of Vulgar Fractions.

1. IF the dividend and the Divisor are both simple Fractions, then multiply the numerator of the dividend into the denominator of the divisor, and the product is a new numerator, and multiply the denominator of the Dividend into the Numerator of the Divisor, and the product is a new Denominator, which new Fraction thus found, is the Quotient you desire. Example.

Quest. 1. What is the Quotient of $\frac{5}{8}$ divided by $\frac{3}{5}$?

Answ. $\frac{25}{24}$ or $1\frac{1}{24}$, for 1*st* I multiply (5) the Numerator of the Dividend into (5) the denominator of the Divisor, and the product (25) is a numerator for the Quotient, then I multiply (8) the denominator of the dividend into (3) the numerator of the Divisor, and the product (24) I put in the quotient for a denominator, so I find $\frac{25}{24}$ is the quotient sought.

$\frac{3}{5}) \frac{5}{8} (\frac{25}{24}$

Quest. 2. What is the quotient of $\frac{10}{21}$ divided by $\frac{2}{3}$?

Answ. $\frac{30}{42}$ equal to $\frac{5}{7}$ in its lowest terms.

2. But if you would divide a simple Fraction by a compound, or a compound by a simple, first reduce

such compound to a simple Fraction, then go on as before.

Queſt. 3. What is the quotient of $\frac{3}{10}$ divided by $\frac{3}{4}$ of $\frac{2}{3}$? *Anſwer* $\frac{36}{60}$ or $\frac{3}{6}$, firſt reduce $\frac{3}{4}$ of $\frac{2}{3}$ into a ſimple Fraction, and it is $\frac{6}{12}$, by which $\frac{3}{10}$ being divided, the Quotient is $\frac{36}{60}$ equal in its leaſt terms to $\frac{3}{5}$. And if the Dividend and Diviſor be both compound Fractions, reduce them both to ſimple Fractions, then divide the one by the other as in Rule 1 beforegoing.

Queſt. 4. What is the Quote of $\frac{2}{3}$ of $\frac{3}{4}$ divided by $\frac{1}{5}$ of $\frac{5}{6}$?

Anſw. $\frac{180}{100}$ or $\frac{18}{10}$ or $1\frac{8}{10}$ or $1\frac{4}{5}$ in its loweſt terms.

3. If the Dividend, or Diviſor, or both are mixt numbers, reduce them to improper Fractions, and perform Diviſion as you were taught before. Example,

Queſt. 5. What is the quote of $12\frac{3}{4}$ divided by $21\frac{4}{5}$?

Anſw. $\frac{255}{430}$, for $12\frac{3}{4}$ is equal to $\frac{51}{4}$ and $21\frac{4}{5}$ is equal to $\frac{109}{5}$, and the quote of $\frac{51}{4}$ divided by $\frac{109}{5}$ is as before $\frac{255}{430}$.

4. If you divide a Fraction by a whole number, or a whole number by a Fraction, make the whole number an improper Fraction by putting an Unit for a denominator to it as was taught in Rule 4. of Chap. 22. and then perform Diviſion as before was taught. Example.

Queſt. 6. What is the Quote of 8 divided by $\frac{3}{5}$?

Anſw. $\frac{40}{3}$ which is equal to $13\frac{1}{3}$ being reduced as is before directed. See the Work in the Margent.

$$\frac{3}{5}\overline{)\frac{8}{1}}\left(\frac{40}{3}\right. \text{ or } 13\tfrac{1}{3}$$

Queſt. 7. What is the Quotient of $\frac{3}{5}$ divided by 8? *Anſwer* $\frac{3}{40}$ as *per Margent.*

$$\frac{8}{1}\overline{)\frac{3}{5}}\left(\frac{3}{40}\right.$$

CHAP.

CHAP. XXIV.

The Rule of Three Direct in Vulgar Fractions.

1. AS in the *Rule of* 3 in whole *Numbers*, ſo likewiſe in *Fractions*, you muſt ſee that the *Fractions* of the firſt and third places be of the ſame denomination.

2. See that if any of the given *Fractions* be compound, that they be reduced to ſimple of the ſame Value.

3. If there are given mixt numbers, reduce them to improper *Fractions* by the firſt Rule of Chap. 19.

4. If any of the three terms is a whole number, make it an improper *Fraction* by conſtituting a Unit for its *denominator*.

Having reduced your *Fraction* as is directed in the 4 laſt *Rules*, then proceed to a Reſolution which is performed the ſame way as in whole numbers, reſpect being had to the Rules delivered for the working of *Fractions*, *viz.* multiply the *2d* and *3d Fraction* together, according to the 1 Rule of Chap. 22. and divide the product by the firſt *Fraction*, according to the 1 Rule of Chap. 23. and the Quotient is the Anſwer.

Or (which is better)

5. Multiply the numerator of the firſt Fraction into the denominators of the ſecond and third, and the product is a new denominator, then multiply the denominator of the firſt Fraction into the numerators of the ſecond and third, and the product is a new numerator; which new Fraction is the *4th* Proportional or anſwer. which (if it is an improper Fraction) muſt be reduced to a whole or mixt number by the third Rule of Chap. 19. Examples,

Queſt. 1. If $\frac{3}{4}$ yards of Cloth coſt $\frac{5}{8}$ *l.* what will $\frac{6}{10}$ *yds* coſt?

Having placed the given Fractions according to the 6 Rule of Chap. 10. I proceed to the reſolution, and firſt I multiply the numerator of the firſt Fraction (3)

into 8 and 10, the denominators of the second and third fractions, and the product is 240 for a denominator, then I multiply 4 the denominator of the first fraction into 5 and 9 the Numerators of the second and third fractions the product is 180 for a Numerator, which Numerator 180 and denominator 240 make $\frac{180}{240}$ *l.* for the Answer, equal to $\frac{3}{4}$ *l.* or 15 *s.*

yds	*l.*	*yds.*	*l.*
3	5	9	180
4	8	10	240
	l.		*l.*
	facit 180	equal to	3
	240		4

Quest. 2. If $\frac{2}{3}$ *l.* buy $\frac{5}{6}$ *yds* of Cloth, what will $\frac{11}{12}$ *yds* cost at that rate?

Answer, $\frac{330}{180}$ *l.* equal to $1\frac{15}{18}$ *l. or* 14 *s.* 8 *d.*

Quest. 3. If $\frac{7}{8}$ *l.* cost $\frac{3}{4}$ *s.* what will $\frac{8}{9}$ *s.* buy?

Answer, $\frac{216}{168}$ *l.* equal to $1\frac{1}{21}$ *l.*

Quest. 4. If $\frac{3}{5}$ of an Ell of Holland cost $\frac{1}{3}$ of a pound, how much will $12\frac{2}{3}$ ells cost at that rate?

Answer, $\frac{190}{27}$ equal to $7\frac{1}{27}$ *l.*

In resolving the last question, and the two next, observe the Third Rule of this Chapter foregoing.

Quest. 5. If $\frac{9}{10}$ of a *C.* cost 284 *s.* what will $7\frac{1}{2}$ *C.* cost at that rate?

Answer, $239\frac{7}{12}$ *s.* or 11 *l.* 19 *s.*, 7 *d.*

Quest. 6. If $3\frac{1}{4}$ yards of Velvet cost $3\frac{5}{8}$ *l.* how much will $10\frac{1}{2}$ yards cost at that rate?

Answer, $11\frac{37}{52}$ *l.*

Quest. 7. If 3 *yds* of Broad Cloth cost $2\frac{4}{5}$ *l.* what will $14\frac{3}{7}$ yds cost?

Answer, 13 *l.* 9 *s.* 4 *d.*

In working the last question and the 4 next, observe the 4 Rule of this Chap. foregoing.

Quest. 8. If 14 *l.* of Pepper cost 14 *s.* $6\frac{3}{5}$ *d.* I demand the price of $73\frac{3}{4}$ *l.*

Answer, 3 *l.* 16 *s.* $7\frac{43}{56}$ *d.*

Quest. 9. If 1 *l.* of Cochenele cost 1 *l.* 5 *s.* what will $36\frac{7}{10}$ *l.* cost?

Answer, 45 *l.* 17 *s.* 6 *d.*

Quest.

Queſt. 10. If one yard of broad-cloth coſt $15\frac{5}{8}$ *s.* what will 4 pieces, each containing $27\frac{3}{7}$ yards at that rate?

Anſwer, 85 *l.* 14 *s.* $3\frac{3}{7}$ *d.*

Queſt. 11. A Mercer bought $3\frac{1}{2}$ pcs of ſilk, each pc qt. $24\frac{2}{3}$ ells at 6 *s.* $0\frac{3}{4}$ *d. per* Ell, I demand the value of $3\frac{1}{2}$ pcs at that rate?

Anſwer, 26 *l.* 3 *s.* $4\frac{3}{4}$ *d.*

In ſolving the 4 next queſtions obſerve the 8. Rule of Chap. 19.

Queſt. 12. If $\frac{2}{5}$ of an ounce of Silver coſt 2 *s.* I demand the price of $11\frac{2}{3}$ *l.* at that rate?

Anſwer, 35 *l.*

Queſt. 13. If $5\frac{1}{7}$ *l.* of Gold is worth $61\frac{5}{7}$ *l. ſterling*, what is 1 grain worth at that rate?

Anſwer, $1\frac{1}{2}$ *d.*

Queſt. 14. If $\frac{3}{4}$ yds of Silk is worth $\frac{3}{5}$ of $\frac{5}{6}$ *l.* what is the price of $15\frac{3}{5}$ El's *Flemiſh*?

Anſwer, 9 *l.* 12 *s.* 6 *d.*

Queſt. 15. If $\frac{2}{3}$ of $\frac{3}{4}$ of a pound of Cloves coſt 6 *s.* $2\frac{2}{7}$ *d.* what coſt the *C.* weight at that rate?

Anſwer, 69 *l.* 6 *s.* 8 *d.*

Note that when the Anſwers to the Queſtions in this and the next Chap. are given in Fractions, they are given in their loweſt Terms.

CHAP. XXV.

The Rule of Three Inverſe in Fractions.

1. IT hath been already taught (in the third Rule of the 11*th* Chap.) how to diſcover when the 4*th* proportional number (to the 3 given numbers) is to be found out by a Rule of 3 Direct, and when by a Rule of Three Inverſe, to which Rule the Learner is now referred.

2 When (in Fractions) you find a queſtion to be ſolved by the Rule of 3 Inverſe, *viz.* when the third Term is the Diviſor, then (having reduced the terms

exactly according to the Rules in Chap. 24.) multiply the numerators of the 3 Fractions into the denominators of the second and first Fractions, and the Product is a new Denominator, then multiply the denominator of the third Fraction into the numerators of second and first Fractions, and the product is a new numerator, which new fraction thus found is the answer to the question.

Quest. 1. If $\frac{3}{4}$ of a yard of Cloth that is 2 *yds* wide will make a Garment, how much of any other Drapery, that is $\frac{4}{5}$ of a yard wide will make the same Garment?

Answer, $2\frac{1}{2}$ *yds*.

Quest. 2. Lent my Friend 46 *l.* for $\frac{4}{5}$ of a year, how much ought he to lend me for $\frac{7}{12}$ of a year?

Answer, $63\frac{3}{5}$ *l.*

Quest. 3. If $\frac{2}{3}$ of a yard of Cloth that is $2\frac{1}{3}$ *yds* wide will make any Garment, what breadth is that Cloth, when $1\frac{3}{4}$ *yds* will make the same Garment?

Answer, $\frac{8}{9}$ of a *yd* wide.

Quest. 4. How many inches in length of a board that is 9 Inches broad will make a Foot square?

Answer, 16 inches in length.

Quest. 5. If when the bushel of Wheat cost $4\frac{3}{4}$ *s.* the penny Loaf weigheth $10\frac{2}{3}$ Ounces, what will it weigh when the bushel cost $8\frac{9}{10}$ *s.*?

Answer, $5\frac{18}{127}$ Ounces.

Quest. 6. If 12 Men can mow $24\frac{1}{2}$ Acres in $10\frac{2}{3}$ days, in how many days will 6 Men do the same?

Answer, In $21\frac{1}{3}$ days.

CHAP. XXVI.

Rules of Practice.

1. IN the single Rule of 3, when the first of the 3 Numbers in the Question (after they are disposed according to the 6th. Rule of Chap. 10.) happeneth to

to be an Unit (or 1) that Queſtion many times may be reſolved far more ſpeedily than by the Rule of 3, which kind of Operation is commonly called Practice, and indeed it is of excellent uſe amongſt Merchants, Tradeſmen and others, by reaſon of its ſpeedineſs in finding a reſolution to ſuch kind of Queſtions.

2. The chiefeſt Queſtion reſolvable by theſe brief Rules may be comprehended under the ſeveral general heads or caſes following, *viz.*

When the given Price of the Integer conſiſts,

1 *Of farthings under* 4
2 *Of pence under* 12
3 *Of pence and farthings*
4 *Of ſhillings under* 20
5 *Of ſhillings, pence and farthings*
6 *Of Pounds*
7 *Of pounds, ſhillings, pence and farthings.*

It would be very convenient for the Practical Arithmetician to have by heart the ſeveral products of the Nine Digits multiplyed by 12, for his ſpeedy reducing pence into ſhillings, or ſhillings into pence, which he may gain by the following Table.

12 Times

1	12
2	24
3	36
4	48
5	60
6	72
7	84
8	96
9	101

3. Shillings are practically reduced into pounds thus, *viz.* cut off the figure ſtanding in the place of Units with a daſh of the pen and note it for ſhillings, then draw a line under the given Number, and take half

half of the remaining figures (after the first is cut off) and set them under the line, and they are so many pounds, but if the last figure is odd, then take the lesser half, and add 10 to the figure so cut off (as before) for shillings, as if I were to reduce 43658 shillings into pounds, first I cut off the last figure (8) for shillings, then I take half of the remaining figures (4365) thus half of 4 is 2, which I put under the line, then $\frac{1}{2}$ of 3 is 1, and because 3 is an odd number, I make the next figure 6 to be 16, and I go on, saying, $\frac{1}{2}$ of 16 is 8, and then $\frac{1}{2}$ of 5 is 2, which is the last figure, wherefore because 5 is an odd number, I add 10 to the 8 I cut off, and it makes 18 *s.* so that I find it to be 2182 *l.* 18 *s.* as *per Margent.*

4365|8	
l.	s.
2182	18

4. It is likewise convenient that the Learner be acquainted with the practical Tables following, the first containing the Aliquot (or even) parts of a shilling, the second containing the Aliquot parts of a pound.

The even Parts of a shilling.

d.	*s.*
6	$\frac{1}{2}$
4	$\frac{1}{3}$
3	$\frac{1}{4}$
2	$\frac{1}{6}$
$1\frac{1}{2}$	$\frac{1}{8}$
1	$\frac{1}{12}$

is

The even parts of a pound

s. *d.*	*l.*
10—00	$\frac{1}{2}$
6—08	$\frac{1}{3}$
5—00	$\frac{1}{4}$
4—00	$\frac{1}{5}$
3—04	$\frac{1}{6}$
2—06	$\frac{1}{8}$
2—00	$\frac{1}{10}$
1—08	$\frac{1}{12}$
1—00	$\frac{1}{20}$

is

Case 1.

5. When the price of the Integer is a Farthing, then take the ſixth Part of the given Number, which will be ſo many three half-pences, and if any thing Remains it is Farthings, by the *7th* Rule of Chap. 9. then conſidet that three half-pence is $\frac{1}{8}$ of a ſhilling, wherefore take the eighth part of them for ſhillings, and if any thing remain they are ſo many 3 half-pence, which reduce into pounds by the Third Rule foregoing. Example, What comes 67486 *l.* to at a Farthing *per l.* Firſt, I take $\frac{1}{6}$ of 67486 and it is 11247 three half-pence and 4 farthings, or one peny; then $\frac{1}{8}$ of 11247 is 1405 *s.* and 7 remains, which is 7 three half-pence, or $10\frac{1}{2}$ *d.* which with the 4 farthings before make $11\frac{1}{2}$ *d.* and 1405 ſhillings, which by the 3 Rule is 70 *l.* 5 *s.* In all 70 *l.* 5 *s.* $11\frac{1}{2}$ *d.* for the *Anſwer.* See the Work following.

		d.
$\frac{1}{6}$	67486 *at* $\frac{1}{4}$ *per l.*	
$\frac{1}{8}$	11247	1
$\frac{1}{2}\frac{1}{0}$	1405	$10\frac{1}{2}$
	l. *s.* *d.*	
	70 — 5 — $11\frac{1}{2}$ *facit*	

Other Examples follow.

$\frac{1}{6}$	8576 *l. at* 1 *qr.*	
$\frac{1}{8}$	1429	2 *qrs.*
$\frac{1}{2}\frac{1}{0}$	1718	8 *d.*
	l. *s.* *d.*	
	8 — 18 — 8 *facit*	

$\frac{1}{6}$	6380 *l. at* 1 *qr.*	
$\frac{1}{8}$	1063	2 *qrs.*
$\frac{1}{2}\frac{1}{0}$	1312	11 *d.*
	l. *s.* *d.*	
	6 — 12 — 11 *facit*	

6. When

6. When the price of the Integer is 2 farthings, then take the third part of the given Number for ſo many three-half-pences, and the Remainder (if any) is half pence, then take the eighth part of that for ſhillings, as before, *&c.*

Examples.

$\frac{1}{3}$	7368 *l.* *at* 2 *qrs.*	
$\frac{1}{8}$	2456	
$\frac{1}{2\,0}$	3017	
	l. s.	
	15 7 *facit*	

$\frac{1}{3}$	8347 *l.* *at* 2 *qrs.*
$\frac{1}{8}$	2782 —— 2 *qrs.*
$\frac{1}{2\,0}$	3417 —— 9 *d.* $\frac{1}{2}$
	l. s. d.
	17—7—9 *facit*

7. When the price of the Integer is 3 farthings, then take half the given Number for three half-pence, (and if any thing remain it is 3 farthings) then take the eighth of that for ſhillings as before, *&c.*

Examples.

$\frac{1}{2}$	4736 *l.* *at* 3 *qrs.*	
$\frac{1}{8}$	2368	
$\frac{1}{2\,0}$	2916	
	l. s.	
	14 —— 16 *facit*	

$\frac{1}{2}$	5425 *l.* *at* 3 *qrs.*
$\frac{1}{8}$	2712 —— 3 *qrs.*
$\frac{1}{2\,0}$	3319
	l. s. d. qrs.
	16--19--0--3 *fa.*

Caſe 2.

8. When the given price of the Integer, is a part, or parts of a ſhilling (*viz.* pence) divide the given Number of Integers (whoſe value is ſought) by the Denominator, of the fraction repreſenting the even part, and the quote is ſhillings, (always minding the 7*th.* Rule of the 9*th.* Chap.) and thoſe ſhillings may be reduced into *l.* by the 3*d.* Rule of this Chapter. Examp. Let it be required to find the value of

438 *l.*

438 *l.* at 3 *d. per l.* I consider 3 *d.* is $\frac{1}{4}$ of a shilling, and 438 *l.* will cost so many 3 pences, wherefore I divide 438 by 4 the denominator of $\frac{1}{4}$, and the quote is 109 shillings, and 2 remains, which is 2 three pences or 6 *d.* the whole value is 5 *l.* 9 *s.* 6 *d.* as by the following work appeareth.

$\frac{1}{4}$	438 *l.* at 3 *d.*
$\frac{1}{20}$	109——6
	l. *s.* *d.*
facit	5.—9—6

More Examples follow.

	l.	*d.*
$\frac{1}{2}$	3574 *at* 6 *per l.*	
$\frac{1}{20}$	1787	
facit	89 *l.* 7 *s.*	

	l.	*d.*
	5316 *at* 2 *per l.*	
$\frac{1}{20}$	886	
facit	44 *l.* 6 *s.*	

	l.	*d.*
$\frac{1}{3}$	438 *at* 4 *per l.*	
$\frac{1}{20}$	146	
facit	7 *l.* 6 *s.*	

	l.	*d.*
$\frac{1}{8}$	6389 *at* $1\frac{1}{2}$ *per l.*	
$\frac{1}{20}$	798——	7 *d.* $\frac{1}{2}$
facit	39 *l.* 18 *s.*	7 *d.* $\frac{1}{2}$.

	l.	*d.*
$\frac{1}{4}$	879 *at* 3 *per l.*	
$\frac{1}{20}$	219—	9 *d.*
facit	10 *l.* 19 *s.*	9 *d.*

	l.	*d.*
$\frac{1}{12}$	818 *at* 1 *per l.*	
$\frac{1}{20}$	68——	2 *d.*
facit	3 *l.* 8 *s.*	2 *d.*

9. If the price of the Integer be pence under 12, and yet not an even part, then it may be divided into even parts, and so the parts of the given Number taken

ken accordingly, and added together, as if it were 5 *d.* which is 3 *d.* and 2 *d. viz.* $\frac{1}{4}$ and $\frac{1}{6}$ of a ſhilling, firſt take $\frac{1}{4}$ of the given number, and then $\frac{1}{6}$ thereof and add them together, and their Sum is the Anſwer in ſhillings, ſtill obſerving Rule 7. of Chap. 9. for the remainders, (if any be) then bring the ſhillings into pounds by the 3 Rule foregoing. Likewiſe 7 *d.* is $\frac{1}{3}$ and $\frac{1}{4}$, ſo 9 *d.* is $\frac{1}{2}$ and $\frac{1}{4}$, and 10 *d.* is $\frac{1}{4}$ and $\frac{1}{4}$, and 11 *d.* is $\frac{1}{3}$ and $\frac{1}{3}$ and $\frac{1}{4}$ of a ſhilling, or elſe many times your work may be ſhortned thus, *viz.* when the ſaid given price is to be divided into even parts of a ſhilling or of a pound, after you have taken the firſt even part, the other may be an even part of that part, as in the next Example, where is given 439 *l.* at 5 *d. per l.* now I may divide it thus, *viz.* into 4 *d.* and 1 *d.* and 4 *d.* being $\frac{1}{3}$ of a ſhilling, and 1 *d.* being $\frac{1}{4}$ of 4 *d.* I firſt take $\frac{1}{3}$ of 439 *l.* and it gives 146 *s.* 4 *d.* and for the 1 *d.* I take $\frac{1}{4}$ of 146 *s.* 4 *d.* which is 36 *s.* 7 *d.* which in all comes to 9 *l.* 2 *s.* 11 *d.* Examples follow.

	l.	d.
	439 *at* 5 *per l.*	
$\frac{1}{3}$	146	4
$\frac{1}{4}$	36	7
	18|2	11
	9 *l.* 2 *s.* 11 *d. facit*	

	yds.	d.
	417 *at*	9 *per yd*
$\frac{1}{2}$	208	6
$\frac{1}{2}$	104	3
	31|2	9
	15 *l.* 12 *s.* 9 *d. facit*	

	ells	d.
	587 *at*	7 *per Ell*
$\frac{1}{3}$	195	8
$\frac{1}{4}$	146	9
	34|2	5
	17 *l.* 2 *s.* 5 *d. facit*	

	ells	d.
	386 *at*	10
$\frac{1}{2}$	193	
$\frac{1}{3}$	128	8
	32|1	8
	16 *l.* 1 *s.* 8 *d. facit*	

	yds.	d.
	836 *at* 8 *per yd*	
⅓	278	8
⅓	278	8
	5517	4
	27*l.* 17*s.* 4*d. facit*	

	l.	d.
	534 *at* 11	
⅓	178	
⅓	178	
¼	133	6
	4819	6

24*l.* 9*s.* 6*d. facit*

Case 3.

10. When the price of the Integer is pence and farthings, if it make an even part of a shilling, work as before, but if they are uneven, as penny farthing, penny three farthings, 2 *d.* 1 *qr.* or 2 *d.* 3 *qrs.* 3 *d.* 3 *qrs.* or the like, then first work for some even part, and then consider what part the rest is of that part, and divide that quotient thereby, then add them together, and reduce them to pounds as before, Example, 3470 *l.* at 1 *d.* 1 *qr.* *per l.* first I work for the penny by dividing 3470 by 12, for 1 *d.* is $\frac{1}{12}$ of a shilling, and the quote is 289 *s.* 2 *d.* then I conceive that one farthing is the ¼ of a peny, and the value at one farthing, will be ¼ of the value at 1 peny, and therefore I take ¼ of 289 *s.* 2 *d.* which is 72 *s.* 3 *d.* 2 *qrs.* and add them together, and they are 18 *l.* 1 *s.* 5 *d.* 2 *qrs.* as by the Margent. Other Examples of the same nature follow.

l.	*qrs.*
3470 *at*	5
289	2
72	3 — 2
361	5 — 2

l.	*s.*	*d.*	*qrs.*
18	1	5	2

	l.	d.
$\frac{1}{12}$	4360 *at*	$1\frac{1}{4}$
$\frac{1}{4}$	363	4
	90	10
	453	$2\frac{1}{4}$
	l.	*s.* *d.*
facit	22	14 2

	yds	d.
$\frac{1}{8}$	573 *at*	$1\frac{3}{4}$
$\frac{1}{6}$	71	$7\frac{1}{2}$ *d.*
	11	$11\frac{3}{4}$
	83	$6\frac{3}{4}$
	l.	*s.* *d.*
facit	4	3 $6\frac{3}{4}$

$\frac{1}{8}$	485 *l. at*	$2\frac{3}{4}$ *d.*
$\frac{1}{8}$	80	10 *d.*
	10	$1\frac{1}{4}$
	510	$11\frac{1}{4}$
	4 *l.* 10 *s.*	$11\frac{1}{4}$ *d.*

$\frac{1}{2}$	520 *yds at*	$7\frac{1}{2}$
$\frac{1}{4}$	260	
	65	
	325	
	16 *l.* 5 *s.*	*facit*

$\frac{1}{6}$	54 *l.* at	$2\frac{1}{2}$ *d.*
$\frac{1}{4}$	109	
	27	3 *d.*
	136	3
	6 *l.* 16 *s.*	3 *d.*

	137 *yds* at	$10\frac{1}{2}$
$\frac{1}{2}$	68	6 *d.*
$\frac{1}{4}$	34	3
$\frac{1}{8}$	17	$1\frac{1}{2}$
	119	$10\frac{1}{2}$ *d.*
	5 *l.* 19 *s.*	$10\frac{1}{2}$ *facit*

Case 4.

11. When the price of the Integer is 2 *s.* then cut off the figure in the place of Units of the given number, and double it for shillings, and the figures on the other hand are pounds. Example 436 *yds* at 2 *s. per yd*, cut off the last figure 6 and double it, it makes 12 shill. and the other 2 figures, *viz.* 43 are so many pounds, so that their value is 43 *l.* 12 *s.* as *per Margent.*

43|6
43 *l.* 12 *s.*

12. Hence

12. Hence it is evident that (when the given price of an Integer is an even number of ſhillings, then if you take half of that (even number of ſhillings, and multiply the given number of Integers thereby, doubling the firſt figure of the product, and ſetting it apart for ſhill. the reſt of the product will be pounds, which pounds and ſhill. is the value ſought. Example, What coſt 536 *yds* at 8 *s. per yd* ? To reſolve which, I take $\frac{1}{2}$ of 8 *s.* (the price of a *yd*) which is 4, and multiply 536 thereby, ſaying, 4 times 6 is 24, then I double the firſt figure 4 makes 8 for ſhill. and carry 2 to the next product, *&c.* I find the reſt of the product to be 214 which I note for pounds, ſo the value of 536 *yds* at 8 *s. per yd* is 214 *l.* 8 *s.* as *per* Margent. More Examples follow.

546 *yds* at 8 *s.*

214 *l.* 8 *s.*

56 yds at 6 s. per yd	420 yds at 12 s. per yd
16 l. 16 s. *facit*	252 l. *facit*
123 yds at 4 s. per yd	326 yds at 14 s. per yd
24 l. 12 s. *facit*	228 l. 4 s. *facit*
48 ells at 8 s. per ell	48 yds at 16 s. per yd
19 l. 4 s. *facit*	38 l. 8 s. *facit*
84 yds at 10 s. per yd	52 yds at 18 s. per yd
42 l. *facit*	46 l. 16 s. *facit*

13. If the given price of the Integer is an odd number of ſhillings, then work firſt for the even number of ſhillings by the laſt Rule, and for the odd ſhilling take $\frac{1}{20}$ of the given Number of Integers according to the 3 Rule of this Chap. and add them together, and you have your deſire. Examples follow.

yds	*s.*		*ells*	*s.*	
422	*at* 3	*per yard*	431	*at* 13	
l.	*s.*		*l.*	*s.*	
42	4		258	12	
21	2		21	11	
63	6	*facit*	280	03	*facit*

ells	*s.*		*ells*	*s.*	
516	*at* 7	*per ell*	324	*at* 17	*per ell*
l.	*s.*		*l.*	*s.*	
154	16		259	4	
25	16		16	4	
180	12	*facit*	275	8	*facit*

14. Except when the given price of the Integer is 5 *s.* for then it is sooner answered by taking $\frac{1}{4}$ of the given Number whose value is sought, as in the following Example.

	yds	*s.*		*ells*	*s.*
$\frac{1}{4}$	436	*at* 5 *per yard*	$\frac{1}{4}$	206	*at* 5 *per ell*
	109 *l.*	*facit*		51 *l.*	10 *s. facit*

Case 5.

15. When the given price of an Integer is shillings and pence, or shillings, pence and farthings; then if the shillings and pence be an even part of a pound, divide the given number of Integers, whose value you seek by the denominator of that Fraction representing that even part. As for Example, what is the price of 384 *yds* at 6 *s.* 8 *d.* *per yd?* Here I consider that 6 *s.* 8 *d.* is $\frac{1}{3}$ of a pound, wherefore

wherefore I divide 384 by 3, and the quote is the Answer, *viz.* 128 *l.* so that 384 *yds* at 6 *s.* 8 *d.* *per yd* amounts to 128 *l.* as *per margent*, still observing the 7*th* Rule of the 9*th* Chapter.

⅓	384
	128 *l. facit*

More Examples follow.

⅓	438 *ells at* 6 *s.* 8 *d.*
	146 *l. facit*
⅙	525 at 3 *s.* 4 *d.*
	87 *l.* 10 *s. facit*

⅛	443 *yds at* 2 *s.* 6 *d.*
	55 *l.* 7 *s.* 6 *d. facit*
1½	726 *yds at* 1 *s.* 8 *d.*
	60 *l.* 10 *s. facit*

16. When the given value of the Integer is shillings and pence, and not an even part of a pound, yet many times it may be divided into parts (*viz.* 6 *s.* 6 *d.* is 4 *s.* and 2 *s.* 6 *d.* for the 4 *s.* work according to the 12 Rule foregoing, and for the 2 *s.* 6 *d.* take the eighth part of the given Number and add them together, then their sum is the value required.)

So 8 *s.* 6 *d.* will be divided into 6 *s.* and 2 *s.* 6 *d.* and the price of the given Number may be found out as before, *&c.* Examples follow.

	yds	*s.*	*d.*
	386 *at*	8	8
⅓	128 *l.*	13	4
1/10	38	12	0
	167 *l.*	5 *s.*	4 *d. facit*

	ells	*s.*	*d.*
s.	540 *at*	5	4
2	54 *l.*	0	*s.*
⅙	90	0	
	144 *l.*	0 *s.*	*facit*

	ells	*s.*	*d.*
s.	427 *at*	8	6
6	128 *l.*	2	0
⅛	53	7	6
	181 *l.*	9 *s.*	6 *d. facit*

	yds	*s.*	*d.*
s.	386 *at*	14	8
8	154 *l.*	8	0
⅓	128	13	4
	283 *l.*	1 *s.*	4 *d. facit*

17. When

17. When the given price of the Integer is ſhillings and pence, and you cannot readily divide them according to the laſt Rule, then multiply the given number whoſe value you ſeek by the number of ſhillings in the price of the Integer, and then for the pence work by the 8*th* Rule foregoing, then add the Numbers together, and their Sum is the value ſought in ſhillings; as for Example, what is the value of 392 *yds.* at 6 *s.* 9 *d. per yard.* Here 6 *s.* 9 *d.* cannot be made any even part, nor indeed can it be divided into even parts of a pound, wherefore I multiply the given number of *yards* 392 by 6, for the 6 *s.* the product is 2352 ſhillings, then for the 9 *d.* I divide it into 6 *d.* and 3 *d.* and work for them by the 8*th* Rule foregoing, and at laſt add the ſhillings together, they make 2646 *s.* and by the 3 Rule they are reduced to 132 *l.* 6 *s.* the value of 392 *yds* at 6 *s.* 9 *d. per yard.* See the work following.

	yds.	*s.*	*d.*
	392	*at* 6	—9
	2352		
½	196		
¼	98		
	2646		

1132 *l.* 6 *s. facit*

Other Examples follow.

	l.	*s.*	*d.*
s.	480	*at* 4	—10
4	1920		
½	240		
⅓	160		
	2320		

116 *l. facit*

	ells	*s.*	*n.*
s.	732	*at* 12	—7
12	8784		
⅓	244		
¼	183		
	9211		

460 *l.* 11 *s. facit*

18. When

18. When the given price of the Integer is shillings, pence and farthings, then multiply the given number of Integers by the number of shillings contained in the value of the Integer, and for the pence and farthings follow the 10*th* Rule of this Chapter.

Examples.

	yds.	*s.*	*d.*
s.	438 *at*	8	6 ¾.
8	3504		
½	219		
⅛	27	4 ½	*d.*
	27510	4 ½	
	fac. 187 *l.* 10 *s.* 4 ½ *d.*		

	ells	*s.*	*d.*
	370 *at*	14	2¾
	1480		
s.	370		
14	5180		*d.*
⅛	61		8
¼	15		5
½	7		8½
	52614		9½
	fac. 263*l.* 4*s.* 9 *d* ½.		

	ells	*s.*	*d.*
s.	136 *at*	9	2 ½
9	1224		0
⅛	22		8
¼	5		8
	12512		4
	fac. 62 *l.* 12 *s.* 4 *d.*		

	ells	*s.*	*d.*
s.	431 *at*	2	4 ½
2	862		
¼	107		9 *d.*
⅛	53		10 ½.
	10213		7 ½
	facit 51*l.* 3*s.* 7½*d.*		

Case

Case 6.

19. When the given value of the Integer is pounds, then multiply the Number of Integers whose value is sought by the price of the Integer, and the product is the answer in pounds.

Examples.

C.	l.		C.	l.
42	at 2	per C.	13	at 8 per C.
84 l. facit			104 l. facit	

C.	l.		C.	l.
30	at 3	per C.	48	at 12 per C.
90 l. facit			576 l. facit	

Case 7.

20. If the price of the Integer is pounds and shillings, then for the pounds work as in the last Rule, and for the shillings as in the 12 and 13 Rules before going; then add the Numbers produced from them both, and the Sum is the Value sought.

Examples.

	C.	l.	s.
	46	at 2	—4
2 l.	92	s.	
4 s.	9	—4	
	101 l. 4 s. facit		

	gross	l.	s.
	82	at 4	—10
4 l.	328		
10 s.	41		
	369 l. facit		

	gross	l.	d.
	58	at 3	—7
3 l.	174	s.	
6 s.	17	—8	
1 s.	2	—18	
	194 l. 6 s. facit		

	gross	l.	s.
	26	at 3	—15
3 l.	78		
14 s.	18	—4	
1 s.	1	—6	
	97 l. 10 s. facit		

21. When

21. When the given price of an Integer consists of pounds, shillings, and pence, with farthings, then work for the shillings, pence, and farthings, first according to the 18 Rule of this Chapter, and find the total value of the given Number, as if there were no pounds, then work with the pounds according to the 19 Rule of this Chapter, and add the Numbers thus found, and their Sum is the total value required.

Examples of this Rule follow.

	C. l. s. d.	C. l. s. d
	213 at 1—13—4½	37 at 3—8—10½
	639	296 d. | 8 s.
	213	18—6 | 6 d.
		9—3 | 3 d.
13 s.	2769 d.	4—7½ | 1½ d.
3 d.	53——3	
1½ d.	26——7½	32|8—4½
	284|8——10½	16 l. 8 s. 4½ d.
		111 | 3 l.
1 l.	142 l. 08 s. 10½ d.	
	213	127 l. 8 s. 4½ d. fac.
	355 l. 8 s. 10½ d. facit	

	gross l. s. d.	gross l. s. d.
	416 at 2—9—3¾	48 at 3—15—11½
9 s.	3744	240
3 d.	104	48
¾ d.	26	720 | 15 s.
		24 | 6 d.
	38714	16 | 4 d.
		6 | 1½ d.
	193 l. 14 s.	76|6
2 l.	832	38—6
		144 | 3 l.
	1025 l. 14 s. facit	182 l. 6 s. facit

22. When there is given the value of an Integer, and it is required to know the value of many such Integers together, with $\frac{1}{4}$ or $\frac{1}{2}$ or $\frac{3}{4}$ of an integer, then first (by the former rules) find out the Value of the given number of Integers, and then for $\frac{1}{4}$ of an integer take $\frac{1}{4}$ of the given value of the Integer, or for $\frac{1}{2}$ take $\frac{1}{2}$ of the given value of the integer, and for $\frac{3}{4}$ first take the $\frac{1}{2}$ of the given value, and then $\frac{1}{2}$ of that $\frac{1}{2}$, setting each part under the precedent, then adding them together, their Sum will be the required value of the Integers and their parts. Example; what is the value of $116\frac{1}{2}$ *yds.* at 4 *s.* 6 *d per yard?* To give an Answer, first I work for the value of 116 *yds.* by the 15*th.* Rule foregoing, and then for the $\frac{1}{2}$ *yd.* I take $\frac{1}{2}$ of 4 *s.* 6 *d.* which is 2 *s.* 3 *d.* and add to the rest found as before, then is that Sum the total value of $116\frac{1}{2}$ *yds.* at 4 *s.* 6 *d. per yard*, which I find to amount to 26 *l.* 4 *s.* 3 *d.* as by the work in the Margent.

yds.	*s*	*d.*
$116\frac{1}{2}$ *at*	4	——·6.

11 *l.* 12*s.*	2*s.*
14—10*d.*	2*s.* 6*d.*
2--3	$\frac{1}{2}$ *yd.*

26—4---3 *facit*

Other Examples follow.

$324\frac{1}{4}$ *yds. at* 4 *s.* 10 *d.*

1296 ——	4 *s.*
162 ——	6 *d.*
108 ——	4 *d.*
1—$2\frac{1}{2}$ *d.*	$\frac{1}{4}$ *yd.*

1561 7 *s.* —— $2\frac{1}{2}$ *d.*

78 *l.* 7 *s* $2\frac{1}{2}$ *d. facit*

$228\frac{3}{4}$ *ells at* 12 *s.* 11 *d.*

2736 ——	12 *s.*
76 ——	4 *d.*
76 ——	4 *d.*
57 ——	3 *d.*
6 — $5\frac{1}{3}$ *d.*	$\frac{1}{3}$ *ell.*
3 — $2\frac{3}{4}$ *d.*	$\frac{1}{4}$ *ell.*

2951 4—$8\frac{1}{4}$ *d.*

147 *l.* 14 *s.* $8\frac{1}{4}$ *d facit*

$720\frac{1}{3}$ *yds. at* 6 *s.* 8 *d.*

240 *l.* 3 *s.* 4 *d. facit*

C.	*qrs.*	*l.*	*l.*	*s.*	*C.*
28	--3	--14 *at*	1	—10	
28 *l.* ——			1 *l.*		
14 *l.* ——			10 *s.*		
00—15 *s.*			$\frac{1}{2}$ *C.*		
7 *s.* 6 *d.*			$\frac{1}{4}$ *C.*		
3 *s.* 9 *d.*			14 *l.*		

43 *l.* 6 *s.* 3 *d. facit*

Many more queſtions may be ſtated, and ſeveral other Rules of Practice may be ſhewn according to the method of divers Authors, but what have been delivered here are ſufficient for the practical Arithmetician in all Caſes whatſoever.

CHAP. XXVII.

The Rule of Barter.

1. BArter is a Rule amongſt Merchants, which (in the Exchanging of one Commdity for another) informs them ſo to proportion their Rates as that neither may ſuſtain loſs.

2. To reſolve Queſtions in Barter, it will not be difficult to him that is acquainted with the Golden Rule, or Rule of 3, it being altogether uſed in reſolving ſuch Queſtions.

Queſt. 1. Two Merchants, (*viz.* A and B) *Barter*, A hath 13, C. 3 *qrs.* 14 *l.* of Pepper at 2 *l.* 16 *s. per C.* and B hath Cotton at 9 *d. per l.* I demand how much Cotton B muſt give A for his Pepper?

Anſwer, 9 *C.* 1 *qr.*

Firſt, find by the Rule of 3, or the Rules of Practice foregoing, how much the Pepper is worth, ſaying,

If 1 *C.* coſt 2 *l.* 16 *s.* what will 13 *C.* 3 *qrs.* 14 *l.* coſt?

Anſwer, 38 *l.* 17 *s.*

Secondly, By the Rule of 3 ſay, if 9 *d.* buy 1 *l.* of Cotton, how much will 38 *l.* 17 *s.* buy?

Anſwer, 9¼ *C.* and ſo much Cotton muſt B give to A for 13 *C.* 3 *qrs.* 14 *l.* of Pepper at 2 *l.* 16 *s. per Cent.* when the Cotton is wrath 9 *d. per l.*

Queſt. 2. Two Merchants (A and B) *barter*, A hath Ginger worth 1 *l.* 17 *s.* 4 *d. per C.* but in *barter* he will have 2 *l.* 16 *s. per C.* B hath Nutmegs worth 5 *l.* 12 *s. per C.* now I demand how B muſt rate his Nutmegs *per C.* to make his gain in *barter* equal to that of A?

Anſwer, 8 *l.* 8 *s.*

Say, By the Rule of 3, If 1 *l.* 17 *s.* 4 *d.* require 2 *l.* 16 *s.* in *barter*, what will 5 *l.* 12 *s.* require in *barter*?

Facit 8 *l.* 8 *s.*

Queſt. 3. A and B *barter*, A hath 120 yards of Broad-cloth worth 6 *s. per yd*, but in *barter* he will have 8 *s. per yd.* B hath Shalloon worth 4 *s. per yd.* Now I demand how many *yds* of Shalloon B muſt give A for his Broad-cloth, making his gain in *barter* equal to that of A?

Anſwer, 180 *yds* of Shalloon.

Firſt (as in the laſt queſtion) find out how B ought to ſell his Shalloon in *barter*, *viz.* ſay if 6 *s.* require 8 *s.* what will 4 *s.* require?

Anſwer, 5 *s.* 4 *d.*

Thus you ſee that B muſt ſell his ſhalloon in *barter* at 5 *s.* 4 *d.* if A ſell his Broad-cloth at 8 *s. per yd.*

It remaineth now to find out how much Shalloon B muſt give for 120 yards of broad-cloth, which after the ſame method uſed to reſolve the firſt Queſtion of this Chapter is found to be 180, and ſo many *yds* of Shalloon muſt B give A for the 120 *yds* of broad-cloth.

Queſt 4. A and B *bartered*, A had 14 *C.* of Sugar worth 6 *d. per l.* for which B gave him 1 *C.* 3 *qrs.* of Cinnamon, I demand how *B* rated his Cinnamon *per l.*

Anſwer, 4 *s per* pound.

Queſt. 5. *A* and *B barter*, *A* hath 4 Tun of Brandy worth 37 *l.* 16 *s.* ready money, but in *barter* he hath 50 *l.* 8 *s. per* Tun, and *A* giveth *B* 21 *C.* 2 *qrs.* 11½ *l.* of Ginger for his 4 Tun of *B*randy, I deſire to know how *B* ſold his Ginger in *barter per C.* and how much it was worth in ready money?

Anſwer,

Answer, For 9 *l.* 6 *s.* and 8 *d.* in Barter, and it was worth 7 *l. per Cent.* in ready money.

Quest. 6. A and B *barter*, A hath 320 dozen of Candles at 4 *s.* 6 *d. per* dozen, for which B giveth him 30 *l.* in money, and the rest in Cotten at 8 *d. per l.* I demand how much Cotten he must give him more than the 30 *l.*?

Answer, 11 *C. qr.*

Quest. 7. A and B *barter*, A hath 608 yards of broad cloth worth 14 *s. per yd.* for which B giveth him 125 *l.* 12 *s.* ready money, and 85 *C* 2 *qrs.* 24 *l.* of Bees Wax, now I desire to know how he reckoned eis Wax *per C.*

Answer 3. 10 *s. per C.*

CHAP. XXVIII.

Questions in Loss and Gain.

Quest. 1. A Merchant bought 436 yards of broadcloth for 8 *s.* 6 *d. per* yard, and selleth it again at 10 *s.* 4 *d. per* yd. now I desire to know how much he gained in the Sale of the 463 yards?

Answer, 39 *l.* 19 *s.* 4 *d.*

First find out by the Rule of Three, or by Practice how much the Cloth cost him at 8 *s.* 6 *d. per yd.* which I find to be 185 *l.* 6 *s.* then by the same Rule find out how much he sold it for, *viz.* 225 *l.* 5 *s.* 4 *d.* then substract 185 *l.* 6 *s.* which it cost him, from 225 *l.* 5 *s.* 4 *d.* which he sold it for, and there remaineth 39 *l.* 19 *s.* 4 *d.* for his gain in the sale thereof.

Otherwise it may sooner be resolved thus, first find out how much he gained *per yd. viz.* substract 3 *s.* 6 *d.* which he gave *per yd.* from 10 *s.* 4 *d.* which he sold it for *per yd.* the remainder is 1 *s.* 10 *d.* for his gains *per yd.* Then say,

If 1 *yd.* gain 1 *s.* 10 *d.* what will 436 *yds.* gain? the *Answ.* by Practice, or the Rule of Three is 39 *l.* 19 *s.* 4 *d.* as was found before.

Quest. 2. A Draper bought 124 *yds.* of Holland cloth, for which he gave 31 *l.* I desire to know how he must sell it *per yd.* to gain 10 *l.* 6 *s.* 8 *d.* in the whole Sale of the 124 *yds?* Answer, at 6 *s.* 8 *d.* *per yd.*

Add the price which it cost him, (*viz.* 31 *l.*) to his intended gain, (*viz.* 10 *l.* 6 *s.* 8 *d.*) the sum is 41 *l.* 6 *s.* 8 *d.* then say,

If 124 *yds.* require 41 *l.* 6 *s.* 8 *d.* what will 1 *yd.* require? by the Rule of Three I find the Answer 6 *s.* 8 *d.*

Quest. A Grocer bought 3 *C.* 1 *qr.* 14 *l.* of Cloves, which cost him 2 *s.* 4 *d.* *per l.* and sold them for 52 *l.* 14 *s.* I desire to know how much he gained in the whole? Answer 8 *l.* 12 *s.*

Quest. 4. A *Draper* bought 86 Kerseys for 129 *l.* I demand how he must sell them *per* piece to gain 15 *l.* in laying out 100 *l.* at the rate? Answer 1 *l.* 14 *s.* 6 *d.* *per* piece; for,

As 100 *l.* is to 115 *l.* so is 129 *l.* to 148 *l.* 7 *s.*

So that by the proportion above, I have found how much he must receive for the 86 Kerseys to gain after the rate of 15 *l.* *per C.* then to find how he must sell them *per* piece. I say,

As 86 pieces are to 148 *l.* 7 *s.* so is 1 piece to 1 *l.* 14 *s.* 6 *d.* which is the number sought.

Quest. 6. A *Grocer* bought 4¼ *C.* of Pepper for 15 *l.* 17 *s.* 4 *d.* and (it proving to be dammified) is willing to lose 12 *l.* 10 *s.* *per Cent.* I demand how he must sell it *per l.* Answer 7 *d.* *per l.*

Subtract 12 *l.* 10 *s.* the loss of 100 *l.* from 100 *l.* and there remains 87 *l.* 10 *s.* then say,

As 100 *l.* is to 87 *l.* 10 *s.* so is 15 *l.* 17 *s.* 4 *d.* to 13 *l.* 17 *s.* 8 *d.* so much as he must sell it all for to lose after the rate propounded, then to know how he must sell it *per l.* I say,

As 13 *l.* 17 *s.* 6 *d.* is to 4¼ *C.* so is 1 *l.* to 7 *d.*

Quest.

Quest. 6. A *Plummer* sold 10 Fodder of Lead (the *fodder* containing 19½ *C.*) for 204 *l.* 15 *s.* and gained after the rate of 12 *l.* 10 *s.* *per* 100 *l.* I demand how much it cost him *per C.*? Answer 18 *s.* 8 *d.*

To resolve this Question add 12 *l.* 10 *s.* (the Gain *per Cent.*) to 100 *l.* and it makes 112 *l.* 10 *s.* then say,

As 112 *l.* 10 *s.* is to 100 *l.* so is 204 *l.* 15 *s.* to 182 *l.*

Which 128 *l.* is the Sum it cost him in all, then reduce your 10 *fodders* to half hundreds and it makes 390, then say,

As 390 half hundreds is to 182 *l.* so is 2 half hundreds to 18 *s.* 8 *d.* the price of 2 half hundreds, or one *C.* weight, and so much it stood him in *per C.* weight.

Quest. 7. A *Merchant* bought 8 Tuns of Wine, which being sophisticated, he selleth for 400 *l.* and loseth after the rate of 12 *l.* in receiving a 100 *l.* now I demand how much it cost him *per Tun*? and how he selleth it *per gallon* to lose after the said rate? *Answ.* it cost 56 l. *per tun*, and he must sell it at 3 *s.* 11 *d.* $2\frac{10}{21}$ *qurs. per gallon* to lose 12 *l.* in receiving 100 *l.*

To resolve this question I consider in the first place, that in receiving 100 *l.* he loseth 12 *l.* therefore 100 *l.* comes in for 112 *l.* laid out, wherefore to find how much he laid out for the whole, I say,

As 100 *l.* is to 112 *l.* so is 400 *l.* to 448 *l.* and so much the 8 Tun cost him, then to find how much it cost *per tun*, I say,

As 8 is to 448 *l.* so is 1 to 56 *l.* the price it cost *per Tun.*

Now to find how he must sell it *per* gall. reduce the 8 Tuns into Gallons, they make 2016, then say,

As 2016 Gallons is to 400 *l.* so is 1 Gall. to 3 *s.* 11 *d.* $2\frac{10}{21}$ *qrs.* the price he must sell it at *per* Gall. to lose as aforesaid.

Queſt. 8. A Merchant bought 8 Tuns of Wine, which being ſophiſticated, he is willing to ſell for 400 *l.* and loſeth at that rate 12 *l.* in laying out 100 *l.* upon the ſame, now I demand how much it coſt him *per* Tun ?

Here I conſider that for 100 *l.* laid out, he receiveth but 88 *l.* therefore to find what the 8 Tuns coſt him, I ſay,

As 88 *l.* is to 100 *l.* ſo is 400 *l.* to $454\frac{6}{11}$ the price it all coſt him, then to find how much *per Tun*, I ſay,

As 8 is to $454\frac{6}{11}$ *l.* ſo is 1 to $56\frac{8}{11}$, or 56 *l.* 16 *s.* 4 *d.* $1\frac{3}{11}$ *qr. per Tun.*

CHAP. XXIX.

Equation of Payments.

1. EQuation of Payments, is that Rule amongſt Merchants whereby we reduce the times for payment of ſeveral Sums of Money, to an equated time for the payment of the whole Debt, without Damage to Debtor or Creditor, and

The Rule is,

2. Multiply the Sums of each particular payment by its reſpective Time, then add the ſeveral products together, and their Sum divide by the total debt, and the quotient thence ariſing is the equated Time for the payment of the whole debt. Example,

Queſt. 1. A is indebted to B in the Sum of 130 *l.* whereof 50 *l.* is to be paid at 2 months, and 50 *l.* at 4 months, and the reſt at 6 months, now they agree to make one payment of the total Sum, the queſtion is what is the equated time for payment without Damage to Debtor or Creditor?

To

To resolve this Question I multiply each payment by its time, *viz.*

50 *l.* *multiplyed by* 2 *mon. produceth*	100
50 *l.* *multiplyed by* 4 *mon. produceth*	200
30 *l.* *multiplyed by* 6 *mon. produceth*	180
The Sum of the Product is	480

Then I divide 480 (the Sum of the Products) by 130 (the total Debt) and the Quotient is $3\frac{9}{13}$ months for the time of paying the whole Debt.

Quest. 2. A Merchant hath owing him 1000 l. to be paid as followeth, *viz.* 600 l. at 4 months, 200 l. at 6 months, and the rest (which is 200 *l.*) at 12 months, and he agreeth with his Debtor to make one payment of the whole, I demand the time of Payment without Damage to Debtor or Creditor?

600 *l.* *multiplyed by* 4 *months is*	2400
200 *l.* *multiplyed by* 6 *months is*	1200
200 *l.* *multiplyed by* 12 *months is*	2400
The Sum of the Product is	6000

and the Sum of the Products (6000) being divided by the whole Debt (1000 *l.*) quotes 6 months for the time of payment of the whole Debt.

3. The truth of this Rule is thus manifest, if the interest of that Money which is paid (by the equated time) after it is due, be equal to the interest of that money which (by the equated time) is paid so much sooner than it is due at any rate *per C.* then the Operation is true, otherwise not. Example,

The Proof of the Rule of Equation of Payments.

In the last Quest. 600 *l.* should have been paid at 4 months, but it is not discharged till 6 months (that is 2 months after it is due) wherefore its interest for 2 months at 6 *per C. per Annum* is 6 *l.* and then

200 l. was to be paid at 6 months, which is the equated time for its payment, therefore no intereſt is reckoned for it, but 200 l. ſhould have been paid at 12 months, but it is to be paid at 6 months, which is 6 months ſooner than it ought, wherefore the intereſt of 200 l. for 6 months is 6 l. (accompting 6 l. *per Cent. per Annum*) which is equal to the intereſt of 600 l. for 2 months, wherefore the work is right.

Queſt. 3. A *Merchant* hath owing him a certain ſum to be diſcharged at 3 equal payments, *viz.* $\frac{1}{3}$ at two months, $\frac{1}{3}$ at four months and $\frac{1}{3}$ at 8 months, the queſtion is, what is the equated time for the payment of the whole Debt?

In queſtions of this nature, (*viz.* where the Debt is divided into equal or unequal parts) each of the parts is to be multiplyed by its time, and the ſum of the product is the Anſwer,

$\frac{1}{3}$ *multiplyed by* 2 *mon. produceth* $\frac{2}{3}$
$\frac{1}{3}$ *multiplyed by* 4 *mon. produceth* $1\frac{1}{3}$
$\frac{1}{3}$ *multiplyed by* 8 *mon. produceth* $2\frac{2}{3}$

The Sum of the Product is $4\frac{2}{3}$

which is $4\frac{2}{3}$ months for the equated time of payment.

If inſtead of the *fractions* (repreſenting the parts) you had wrought by the numbers themſelves (repreſented by thoſe parts) according to the firſt and ſecond Examples, it would have been the ſame Anſwer, as ſuppoſe the Debt had been 90 *l.* then $\frac{1}{3}$ of it is 30 *l.* for each payment, *viz.* at 2, 4, and 8 months, then

30 *l. multiplyed by* 2 *mon. produceth* 60
30 *l. multiplyed by* 4 *mon. produceth* 120
30 *l. multiplyed by* 8 *mon. produceth* 240

The Sum of the product is 240

which divided by 90 (the whole debt) quoteth $4\frac{60}{90}$ or $4\frac{2}{3}$ months as before.

Queſt. 4.

Quest. 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Months, and $\frac{1}{4}$ at 10 Months, and he agreeth with his Creditor to make one total payment; I demand the time, without damage to Debtor or Creditor? Work as in the last Question, and you will find the Answer to be 7 Months.

Quest. 5. *A* is indebted to *B* 640 *l.* Whereof he is to pay 40 *l.* present Money, and 350 *l.* at 3 Months, and the rest (*viz.* 250 *l.*) at 8 Months, and they agree to make an Equated time for the whole Payment; now I demand the time?

In questions of this Nature, (*viz.* where there is ready money paid) you are (in Multiplying) to neglect the Money that is to be paid present, and work with the rest as is before directed, and divide the Sum of the products by the whole Debt, and the Quote is the Answer: For here 40 *l.* is to be paid present, and hath no time allowed, and according to the Rule it should be multiplied by its time, which is (0) therefore 40 times 0 is 0, which neither augmenteth nor diminisheth the Dividend; wherefore (to proceed according to direction) I say,

350 *by* 3 *Months produceth* ——— 1050
250 *by* 8 *Months produceth* ——— 2000

The Sum of the product is ——— 3050

which divided by 640, the whole Debt, the Quote is $4\frac{49}{64}$ Months, the time of Payment.

Quest. 6. *A* is indebted to *B* in a certain Sum, $\frac{1}{3}$ whereof is to be paid present Money, $\frac{1}{3}$ at 6 Months, and the rest at 8 Months; now I demand the Equated time for the payment of it all?

Answer, $3\frac{1}{7}$ Months is the time of payment.

Quest. 7. *A* is indebted to *B* 120 *l.* whereof $\frac{1}{3}$ is to be paid at 3 months, $\frac{1}{4}$ at 6 months, and the rest at 9 months; what is the Equated time for the payment of the whole Sum?

Answer,

Anſwer, At 6 ¼ months.

Queſt. 8. *A* is indebted to *B* 420 *l.* which is due at the end of 6 months, but *A* is willing to pay him 140 *l.* preſent, provided he can have the remainder forborn ſo much the longer to make ſatisfaction for his kindneſs, which is agreed upon, I deſire to know what time ought to be allotted for the payment of the 280 *l.* remaining?

To reſolve this Queſtion, firſt, find out what is the intereſt of 140 *l.* for the time it was paid before it was due, at 6 *per Cent.* (or any other rate) (*viz.* 6 months) and you will find it to be 4 *l.* 4 *s.* Then it is evident that the remaining 280 *l.* muſt be detained ſo much longer than 6 mon. as the while it may eat out that intereſt, *viz.* 4 *l.* 4 *s.* which is thus found out, *viz.* Firſt, ſee what is the Intereſt of 280 *l.* for a month, or any other time; but here we will take one month, and its Intereſt, for one month is 28 *s.*

Then by the Rule of Three, ſay,

As 28 *s.* is to 1 month; ſo is 84 *s.* to 3 months; ſo that the 280 *l.* remaining muſt be kept 3 months, beyond its firſt time of payment, (*viz* 6 months) which added thereto, makes 9 months, at the end of which time *A* ought to make payment of the remainder.

CHAP. XXX.

EXCHANGE.

1. THE Rule of Exchange informeth Merchants how to exchange Moneys, Weights, or Meaſures of one Country into (or for) the Moneys, Weights, or Meaſures of another Country, and when the Rate, Reaſon, or Proportion betwixt the Money, Weights, or Meaſures of different Countreys is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or Rule of Three) to ſolve any Queſtion wherein it is required

to

to Exchange a given quantity of the one kind, into the same value of another kind.

2. In Questions of Exchange there is always a comparison made between the Coyns, *&c.* of two Countries (or kinds) or of more.

3. In Questions where there is a comparison made between two things, (whether they be Moneys, Weights, *&c.*) of different kinds or (Countries) there may be a solution found by a single Rule of Three, as may appear by the following Example.

Quest. 1. A Merchant at *London* delivered 370 *l. Sterling*, to receive the same at *Paris* in *French* Crowns, the Exchange $3\frac{1}{5}$ *French* Crowns *per* pound *Sterling*. I demand how many *French* Crowns ought he to receive?

In placing the numbers observe the 6 Rule of the 10 Chapter, which being done, the given numbers will stand thus,

l.	*Crowns*	*l.*
1	$3\frac{1}{5}$	370

and being reduced according to the Rules of the 24 Chapter, will stand thus;

l.	*Crowns*	*l.*	*Crowns*
As $\frac{1}{1}$	is to $\frac{16}{5}$	so is $\frac{370}{1}$	to $1233\frac{1}{3}$

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* for his 370 *l.* delivered at *London*.

Quest. 2. A Merchant delivered at *Amsterdam* 587 *l. Flemish* to receive the value thereof at *Naples* in Ducats the Exchange $4\frac{4}{5}$ Ducats *per l. Flemish*. I demand how many Ducats he ought to receive?

The proportion is as followeth.

l.	*Ducats*	*l.*	*Ducats*
As $\frac{1}{1}$	is to $\frac{24}{5}$	so is $\frac{587}{1}$	to $2817\frac{3}{5}$

So I find he ought to receive $2817\frac{3}{5}$ Ducats at *Naples* for the 587 *l. Flemish* delivered at *Amsterdam*.

Quest. 3. A Merchant at *Florence* delivereth 3478 Ducatoons, to receive the value at *London* in Pence, the Exchange $53\frac{1}{2}$ pence *Sterling per* Ducatoon; I demand how much *Sterling* he ought to receive?

The

The Proportion for Resolutions,

Duc. d. Duc. d
As $\frac{1}{1}$ is to $1\ 0\frac{7}{2}$ so is $347\frac{8}{1}$ to 186073

which is equal to 775*l.* $6\frac{1}{2}$ for the Answer.

I might here (according to the Custom of Arithmetical Writers) lay down Tables for the Reduction of Foreign Coyns to *English*; but by Reason of their Instability (for they continue not at a constant standard, as our *Sterling* Money doth, but are sometimes raised, and sometimes depressed) I shall forbear.

4. When there is a Comparison made between more than two different Coyns, Weights, or Measures, there ariseth ordinarily two different cases from such a Comparison

1. When it is required to know how many pieces of the first Coyn, Weight, or Measure are equal in value to a known number of Pieces of the last Coyn, Weight, or Measure.

2. When it is required to find out how many Pieces of the last Coyn, Weight, or Measure are equal in Value to a given Number of the first sort of Coyn, Weight, or Measure.

An Example of the first Case may be this, VIZ.

Quest. 4. If 150 pence at *London* are equal to 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Brussels*, then how many pence at *London* are equal to 138 Shillings at *Brussels*? *Facit* 960 *d.*

This Question may be resolved at two single Rules of Three; for first I say,

If $\frac{3}{1}$ Ducats at *Naples* make 150 Pence *London*, how many Pence will $4\frac{4}{5}$ Ducats make?

Answer, 240 Pence.

By the foregoing Proportion, we have discovered that $4\frac{4}{5}$ Ducats at *Naples* make 240 Pence at

London

London: And by the Tenour of the Question we see that $4\frac{4}{5}$ Ducats at *Venice* make $34\frac{1}{2}$ shillings at *Brussels*, therefore 240 *d.* at *Lond.* are equal to $34\frac{1}{2}s$ at *Brussels*, (for the things that are equal to one and the same thing are also equal to one another) wherefore we have a way laid open to give a solution to this Question by another Single Rule of Three, whose Proportion is,

As $34\frac{1}{2}$ shillings at *Brussels* is to 240 pence at *London*, so is 138 shill. at *Brussels* to 960 pence at *London*, which is the Answer to the Question.

An Example of the second Case may be thus, VIZ.

Quest. 5 If 40 *l. Averdupois* weight at *London* is equal to 36 *l.* weight at *Amsterdam*, and 90 *l.* at *Amsterdam* makes 116 *l.* at *Dantzick* then how many pounds at *Dantzick* are equal to 112 *l.* of *Averdupios* weight at *London*?

Answer, $129\frac{23}{25}$ pounds at *Dantzick*.

This Question is likewise answered at two single Rules of Three, *viz.* First, I say,

As 36 *l* at *Amsterdam* is to 40 *l.* at *Lond.*

So is 90 *l.* at *Amsterdam* to 100 *l.* at *Lond.*

And by the Question you find that 90 *l.* at *Amsterdam* is 116 *l.* at *Dantzick*, and therefore 100 *l.* at *London* is likewise equal thereunto, wherefore again, I say,

As 100 *l.* at *London* is to 116 *l.* at *Dantzick*,

So is 112 *l.* at *Lond.* to $129\frac{23}{25}l.$ at *Dantzick*.

By which I find that $112\frac{23}{25}l.$ at *Dantzick* are equal to 112 *l Averdupois* weight at *Lond.*

5. There is a more speedy way to resolve such Questions as are contained under the two Cases beforementioned, laid down by Mr. *Kersey* in the third Chapter of his Appendix to Mr *Wingate's* Arithmetick, where he hath given two Rules for the Resolution of the Questions pertinent to the two said Cases.

6 But I shall lay down a general Rule for the solution of both Cases; and first, let the Learner observe the following Directions in placing of the given terms, *viz.*

7. Let there be made two Columns, and in theſe Columns ſo place the given terms one over the other, as that in the ſame Column there may not be found two terms of the ſame kind one with the other.

Having thus placed the Terms, the General Rule is,

Obſerve which of the ſaid Columns hath the moſt Terms placed in it, and multiply all the Terms therein continually, and place the laſt product for a Dividend; then multiply the Terms in the other Column continually, and let the laſt Product be a Diviſor, then divide the ſaid Dividend by the ſaid Diviſor, and the Quotient thence ariſing is the Anſwer to the Queſtion.

So the Example of the firſt of the ſaid Caſes being again repeated, *viz.* if 150 pence at *London* make 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ ſhill. at *Bruſſels*, then how many Pence at *London* are equal to 138 ſhillings at *Bruſſels*?

The terms being placed according to the *7th* Rule will ſtand as followeth.

	A	B	
Pence at Lond.	150	3	*Ducats at Na.*
Ducats at Na.	$4\frac{4}{5}$	$34\frac{1}{2}$	*Shill. at Bruſſ.*
Shill. at Bruſſ.	138		

having thus placed the Terms that in either Column there is two Terms of one kind, then obſerve that the Column under A hath moſt terms in it, therefore they muſt be multiplyed together for a Dividend; viz. 150 mult. by $4\frac{4}{5}$ produceth $360\frac{0}{5}$ which multiplyed by 138 produceth $49680\frac{0}{5}$ for a Dividend, then in the Column under B there are 3 and $34\frac{1}{2}$ which multiplyed together, produce $207\frac{0}{2}$ for a Diviſor; then having divided $49680\frac{0}{5}$ by $207\frac{0}{2}$, the Quotient is 960 pence for the anſwer as before.

Again, let the Example of the ſecond caſe be again repeated, *viz.* If 40 *l.* Averdupois weight at *London* make 36 *l.* weight at *Amſterdam*, and 90 *l.* at *Amſterdam* make 116 *l.* at *Dantzick*, then how many pounds at *Dantzick* are equal to 112 *l.* *Averdupois* weight at *London*,

The

The terms being diſpoſed according to the *7th.* Rule foregoing will ſtand thus,

	A	B	
l. at Lond.	40	36	*l. at Amſterdam*
l. at Amſt.	90	116	*l. at Dantzick*
		112	*l. at London.*

whereby I find that the terms under *B* multiplyed together produce 467712 for a dividend, and the terms under *A*, *viz.* 40 and 90 produce 3600 for a Diviſor, and Diviſion being finiſhed, the quotient giveth $129\frac{3}{5}\frac{3}{6}\frac{12}{00}$ pounds at *Dantzick* for the Anſwer.

CHAP. XXXI.

Single Poſition.

1. NEgative Arithmetick, called the Rule of Falſe, is that by which we find out a truth, by numbers invented or ſuppoſed, and this is either ſingle or double.

2. The Rule of Single Poſition is when at once, *viz.* by one Falſe poſition, or feigned number, we find out the true Number ſought.

3. In the ſingle Rule of Falſe, when you have made choice of your poſition, work it according to the tenour of the queſtion, as if it were the true number ſought, and if by the ordering of your poſition you find the reſult either too much or too little you may then find out the number ſought by this proportion following, *Viz.*

As the reſult of your poſition is to the poſition, ſo is the given number to the number ſought.

Example.

Queſt. 1. A Perſon having about him a certain number of Crowns, ſaid if the fourth and third and ſixth of them were added together, they would make juſt 45, now I demand the number of Crowns he had about him? *Anſwer*, 60 Crowns.

To

To resolve this question I suppose he had 24 Crowns (or any other number that will admit of the like division) now the fourth of 24 is 6, and the third is 8, and the sixth is 4, all which parts (*viz.* 6, 8, and 4,) being added together make but 18, but it should be 45, wherefore I say by the Rule of Three,

As 18, the sum of the parts is to the position 24, so is 45 the given number to 60 the true number sought.

For the fourth of 60 is 15, and the third of 60 is 20, and the sixth of 60 is 10, which added together make 45.

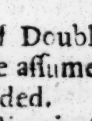
Quest. 2. Three Persons, *viz.* A. B, C, thus discourse together concerning their Age, quoth B to A, I am as old, and half as old again as you, then quoth C to B I am twice as old as you, then quoth A to them and I am sure the Sum of all our Ages is 165. now I demand each mans Age? *Answer*, A 30, B 45, C 90 years of Age, which added together, make 165.

CHAP. XXXII.

Double Position.

1. THE Rule of Double Position is when 2 false positions are assumed to give a Resolution to the question propounded.

2. When any Question is stated in double position make such a Cross as followeth.



3. Then make choice of any number you think may be convenient for your working, which call your first Position, and place it at that end of the Cross at *a*, then work with this position (as if it were the true number

number ſought) according to the nature of your queſtion, then having found out your errour, either too much or too little, place it on that ſide the Croſs *d*, then make choice of another number of the ſame denomination with the firſt poſition (which call your ſecond poſition) and place it on that ſide of the Croſs at *b*, then work with this poſition as with the former, and having found out your error, either too much or too little, place it on that ſide of the Croſs at *c*, and then the poſitions will ſtand at the top of the croſs, and the errors at the bottom, each under his correſpondent poſition, and then multiply the errors into the poſitions croſs-wiſe, that is to ſay, multiply the firſt poſition by the ſecond error, and the ſecond poſition by the firſt error, and put each product over its poſition.

4. Having proceeded ſo far, then conſider whether the errors were both alike, that is, whether they were both too much, or both too little, and if they are alike, then ſubtract the leſſer product from the greater, and ſet the remainder for a dividend, then ſubtract the leſſer Error from the greater, and let the remainder be a diviſor, then the quotient ariſing by this Diviſion is the anſwer to the queſtion.

5. But if the errors are unlike, that is one too much and the other too little, then add the products of the poſitions and errors together, and their Sum ſhall be a dividend, then add the errors together, and their Sum ſhall be a Diviſor, and the Quotient ariſing hence is the Anſwer; which two laſt Rules may be kept in memory by this Verſe following, *viz.*

When Errors are of unlike kinds
Addition *doth enſue,*
But if alike, Subtraction *finds*
Dividing work for you.

Queſt. 1. A, B, and C build a Houſe which coſt 76*l.* of which A paid a certain Sum unknown, B paid

B paid as much as A, and 10*l.* over, and C paid as much as A and B, now I desire to know each mans Share in that Charge?

Having made a Croſs according to the 2 Rule, I come according to the third Rule to make choice of my firſt poſition, and here I ſuppoſe A paid 6*l.* which I put upon the Croſs as you ſee, then B paid 16*l.* (for it is ſaid he paid 10*l.* more than A) and C paid 22*l.* for 'tis ſaid he paid as much as A and B, then I add their parts.

l.				*l.*
9				A 6
19				B 16
28	120	168	288	C 22
	6		9	
56	12)	X	(14	*Sum* 44
	32		20	
76		12		76
56				44
20				*error* 32

and they amount to 44, but it is ſaid they paid 76*l.* wherefore it is 32 too little, which I note down at the bottom of the Croſs under its poſition for the firſt error.

Secondly, I ſuppoſe A paid 9*l.* then B paid 19*l.* and C 28*l.* all which added together, make 56, but they ſhould make 76, wherefore the error of this poſition is 20, which I put at the bottom of the Croſs under his poſition for the ſecond *Error*, then I multiply the *Errors* and the *Poſitions* Croſs-wiſe, *viz.* 32 (the *Error* of the firſt *Poſition*) by 9 (the ſecond *Poſition*,) and the product is 288. Then I multiply 20 (the *Error* of the ſecond *Poſition*) by 6 (the firſt *poſition*) and the Product is 120.

Then (according to the 4*th.* Rule) I ſubtract the leſſer Product from the greater, (*viz.* 120. from 288, becauſe the *Errors* are both alike, *viz.* too little) and

and there remaineth 168 for a Dividend, then I ſubſtract 20, (the leſſer *Error*) from 32 (the greater *Error*) and the Remainder is 12 for a Diviſor, then divide 168 by 12, and the Quotient is 14 for the Anſwer, which is the ſhare of *A* in the Payment.

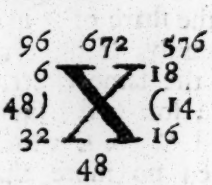
6. Again Secondly, If the errors had been both too big it had had the ſame effect, as appeareth by the following work; for firſt I ſuppoſe *A* paid 20 *l.* then *B* paid 30 *l.* and *C.* 50. *l.* which in all is 100, but it ſhould have been no more than 76, wherefore the firſt Error is 24 too much. Again, I ſuppoſe *A* paid 18 *l.* then *B* muſt pay 28 *l.* and *C* muſt pay 46 *l* which in all

20 A			A 18
30 B			B 28
50 C	320 112 432		C 46
	20 X 18		
100 *ſum*	8) (14 *facit*		*ſum* 92
76 *ſubtr.*	24 16		*ſubtr.* 76
	8		
24 *error*			*error* 16

is 92 *l.* but it ſhould have been but 76 *l.* wherefore the ſecond *Error* is 16 too much; then I multiply 20 (the firſt *Poſition*) by 16 (the ſecond *Error*) and the Product is 320, again I multiply 18, (the ſecond *Poſition*) by 24 (the firſt Error) and the product is 432. Then becauſe the Errors are both too much, I ſubſtract 320 (the leſſer product) from 432 (the greater product,) and there remaineth 112 for a Dividend, likewiſe I ſubſtract (16 the leſſer Error) from 24 (the greater Error,) and the difference is 8 for a Diviſor, then perform Diviſion, and the Quotient is 14, (as before) for the anſwer.

Again Thirdly, If the Errors had been the one too big and the other too little, Reſpect being had to the 5*th.* Rule foregoing, the Anſwer would have been the ſame; as thus, I take for my firſt *Poſition* 6, and then the Error is 32 too little, then I take

take for my second Position 18, and then the error is 16 too much, then I multiply the Positions and errors Cross-wise, and the products are 96 and 576, and because the errors are unlike,



(*viz.*) one too big, and another too little, I add the products 96 and 576 together, and their Sum is 672 for a *Dividend*, I likewise add the errors 32 and 16 together, and their Sum is 48 for a Divisor, then having finished Division, I find the Quotient to be 14, which is the answer as was found out at the 2 several Tryals before.

For proof of the Work I say,

	l.
If A *paid*	14
Then B *paid* 14 *and* 10 (*that is*)	24
Then C *paid* 14 *and* 24 (*that is*)	38
The Sum of all is	76

which is the total value of the building and equal to the given Number.

Those who desire to see the demonstration of this Rule, let them read the *7th.* Chap. of Mr. *Kersey's* Appendix to *Wingates* Arithmetick, *Petiscus* in the *5th.* Book of his *Trigonometria.* Or Mr. *Oughtred* in his *Clavis Mathematica.*

Quest. 2. Three Persons, A, B, C, thus discoursed together concerning their Age; quoth A I am 18 years of Age, quoth B I am as old as A and $\frac{1}{2}$ C; and quoth C I am as old as you both, if your years were added together. Now I desire to know the Age of each Person? Answer A is 18, B is 54, and C is 72 years of Age.

Quest. 3.

Queſt. 3. A Father lying at the point of Death, left to his 3 Sons, *viz.* A, B, C, all his Eſtate in Money, and divideth it as followeth, *viz.* to A he gave $\frac{1}{2}$ wanting 44 *l.* to B he gave $\frac{1}{3}$ and 14 *l.* over, and to C he gave the Remainder, which was 82 *l.* leſs than the ſhare of B, now I demand what was the Sum left, and each mans part? Anſwer, The Sum bequeathed was 588 *l.* and whereof A had 252 *l.* B had 210 *l.* and C had 128 *l.*

Queſt. 4. Two perſons, *viz.* A and B had each in their hands a certain number of Crowns, and A ſaid to B, if you give me 1 of your Crowns I ſhall have 5 times as many as you, and ſaid B to him again, if you give me one of yours, then we ſhall each of us have an equal number; now I demand how many Crowns had each Perſon? Anſwer, A had 4, and B had 2 Crowns.

Queſt. 5. What number is that unto which if I add $\frac{1}{4}$ of it ſelf, and from the Sum ſubtract $\frac{1}{8}$ of it ſelf, the Remainder will be 210? *Anſwer*, 192.

Many more queſtions may be added, but theſe well underſtood, will be ſufficient, (even for the meaneſt Capacity) for the Reſolution of any other queſtion pertinent to this Rule.

There may be an objection made becauſe we have not treated particularly upon Intereſt and Rebate, but the operation of ſuch Queſtions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

Laus Deo Soli.

FINIS.

Books Sold by Eben Tracy, *at the* Three Bibles *on* London-Bridge.

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COCKER'S GRAVE

IN an unmarked grave in St. George's Church in the Borough lies Edward Cocker, who gave the phrase "according to Cocker" to the English tongue.

He lived in the time of Charles I., the Commonwealth and Charles II., and his book of arithmetic, long since superseded, ran through 60 editions. If Cocker is cited, it implies that the thing said is correct.

W. B.

Daily Telegraph, April 9. 1927

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